THIRTEENTH ANNUAL REPORT

OF THE

# Quebec Society for the Protection of Plants

## 1920-1921

Supplement to the report of the Minister of Agriculture

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QUEBEC.

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# Quebec Society for the Protection of Plants

**1920 - 1921**

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To the Honourable J. E. Caron, M.P.P.,

Minister of Agriculture,

Quebec.

Sir :—

I have the honour to present herewith the thirteenth Annual Report of the Quebec Society for the Protection of Plants, containing the proceedings of the winter meeting of the Society, which was held at Macdonald College, Ste. Anne de Bellevue, Que., on the 1st of March, 1921.

Included are the papers that were read, and the reports of the officers of the Society.

I have the honour to be,

Sir,

Your obedient servant,

B. T. DICKSON,

Secretary-Treasurer

Macdonald College, Quebec.

# QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS.

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| Simard, J. | Dept. of Agr., Quebec |
| Simmonds, P. M. | Macdonald College |
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| Swaine, Dr. J. M. | Entomological Branch, Dept. of Agr., Ott· |
| Tawse, W. | Macdonald College |
| Tessier, G. | Forest Service, Quebec |
| Victorin, Rev. Bro. | Longueuil, Que. |
| Willey, Prof. A. | 58 Metcalfe St., Montreal |
| Winn, A. F. | 32 Springfield Ave., Westmount |

## HONORARY MEMBERS

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Rev. Father Superior, La Trappe.
Auguste Dupuis, Village des Aulnaies.
Hon. Hules Allard, M.P.P., Quebec.
Canon V.A. Huard, DSc., Quebec.
Rev. Father Superior, Ste. Anne de la Pocatière.

## FINANCIAL STATEMENT FOR 1920-21

### Receipts

| | |
|---|---|
| Brought forward | $127..58 |
| Provincial Government grant | 250..00 |
| Interest on deposit | 5..98 |
| | $383..56 |

### Disbursements

| | |
|---|---|
| Lecturers and delegates | $ 51.42 |
| Delegates to Ont. Entom. Soc. | 81..65 |
| Delegate to Canadian Phytopath. Soc | 41..00 |
| Printing programs | 7..07 |
| Secretary | 50..00 |
| | $231..14 |
| Balance in bank, May 16, 1921 | 152..42 |
| | 383..56 |

NOTE.—Postage and stenographic account not included.

Auditor :—

E. MELVILLE DU PORTE.

B. T. DICKSON,
Secretary-treasurer

W. LOCHHEAD,
President.

# QUEBEC SOCIETY FOR THE PROTECTION OF PLANTS

## REPORT OF THE WINTER MEETING

The thirteenth annual meeting of the Quebec Society for the Protection of Plants was held in the Biology Building of Macdonald College, on Tuesday, March 1st 1921.

### Business Meeting

The business meeting was opened by the President, Prof. W. Lochhead, at 2.00 p. m. Among those present were :—Rev. Father Leopold, Dr. W. T. MacClement, Dr. F. C. Harrison, Dr. J. C. Chapais, Prof. Dickson, Prof. Bunting, Prof. Letourneau, Prof. McRostie, Mr. A. Gibson, Mr. L. S. McLaine, Mr. C. E. Petch, Mr. Winn, Mr. Coderre, Mr. Blair, Mr. MacMahon, Mr. Grindley, Mr. Maheux, Mr. Caron, Mr. Roy, Mr. Crawford, Mr. Kelsall, Mr. Tawse, Mr. Howitt, Mr. Saunders, Mr. Milne, Mr. Hockey, Mr. Hethrington, Mr. Major,Mr. Richardson, Miss D. Newton, Mr. Simmonds and others.

The minutes of the last meeting were approved.

The report of the treasurer was read and accepted.

The following were the officers appointed for the following year :—

President :—Prof. W. Lochhead, Macdonald College.

Vice-President :—Rev. Fr. Leopold, La Trappe.

Secretary-treasurer :—Prof. B. T. Dickson, Macdonald College.

Directors : Rev. Dr. Fyles, Ottawa.
Prof. Letourneau, La Trappe.
A. F. Winn, Esq., Montreal.
Rev. Prof. Fontanel, Montreal.
G. Maheux, Esq., Provincial Entomologist, Quebec.
G. Chagnon, Esq., Montreal.
Prof. G. Bouchard, Ste. Anne de la Pocatière.
Dr. A. T. Charron, St. Hyacinthe.

Auditor :—E. Melville DuPorte, Macdonald College.

Delegate to the Royal Society of Canada., Prof. W. Lochhead.

Delegates to the Ontario Entomological Society : Prof. W. Lochhead, and either Mr. H. Roy or Prof. Bouchard.

Delegates to the Canadian Branch of the American Phytopathological Society : Prof. B. T. Dickson and Prof. Letourneau.

It was resolved that the Society, so far as funds are available, continue to help in aiding investigations concerning economic diseases caused by insects, fungi, or bacteria.

A communication from the British Columbia Entomological Society was read by the Secretary regarding proposals for the publication of entomological

articles. It was decided that, in view of the fact that our Society serves as a medium for more than papers dealing with entomological questions, the matter be kept under advisement until the next annual meeting.

It was decided to hold the summer meeting at the discretion of the Executive.

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## GENERAL SESSION

The general session of the thirteenth annual meeting was opened at 3.00 p. m. in the Biology Building of Macdonald College, by the President, Prof. W. Lochhead.

Dr. F. C. Harrison, Principal of Macdonald College, extended a cordial welcome to the visitors and delegates. The addresses and papers are printed in detail in the body of the Annual Report. The guests of the Society were Prof. H. H. Whetzel, head of the Department of Plant Pathology of Cornell University, Dr. W. T. MacClement, Professor of Botany at Queen's University, Kingston, and Mr. A. Gibson, Dominion Entomologist, Ottawa. Mr. Gibson gave a very interesting talk on the work and equipment, both material and personal, of the Dominion Entomological Service. His talk was well illustrated by lantern slides.

## ADDRESS OF WELCOME

**By Principal Harrison**

It gives me great pleasure indeed to have with us again the visitors and delegates to the Society. At previous meetings we have had a number of representatives from the Experimental Farm at Ottawa, from our friends at Oka and Quebec, and also, as a rule, a distinguished visitor or two from the great Republic to the South of us, and this year is no exception to that rule. Among those from Ottawa is the new Dominion Entomologist in his official capacity and we congratulate him on his appointment to this post and give him a special welcome ; Father Leopold from Oka and representatives from the Quebec Department of Agriculture are also present, and we are glad to see them and meet them on the common ground f the subjects taken up by the Society.

We are particularly pleased on this occasion to welcome Professor W. T. MacClement, of Queens University, and Professor Whetzel, of Cornell University. Cornell has always kept in touch with Canadian Institutions—especially Institutions of Agriculture. A large number of our staff have studied at Cornell so that when we have visitors from that University, we do not look on them merely as visitors, but have a much warmer feeling for them. As a postgraduate

student of that University I am glad to welcome its distinguished representatives. It is many years since I was at Cornell, but there are many members of their excellent teaching staff whom I remember with pleasure—Professor Atkinson, Dr. Rowlee, Professor Comstock and his inestimable lady—these have helped a great many of us and have left a lasting impression for the very hospitable welcome always given Canadians. I was only speaking a short time ago about Mrs. Comstock and I made the remark that she was the only American lady I knew who could ever attempt to run a salon.

This society accomplishes a great work in that it brings together a large number of distinguished individuals. When these specialists meet and exchange views, they brush away some of our mental cobwebs and give us new views, and after they have gone we want to go to work with redoubled energy. We welcome the opportunity of meeting these specialists, for frequently conventions are held so far away that it is difficult for members of this institution to attend them. It is an inspiration to meet others working along the same lines,so we welcome this gathering of experts, both for its influence on those members of our staff who are engaged in similar lines of work, and for the opportunity it offers to our senior students to gain new viewpoints.

Since last meeting there have been some changes which I should like to refer to as briefly as possible. We had here formerly Botany and Entomology under one Department, but last fall these have been placed in separate departments. In small institutions it is difficult to arrange for full specialisation. We have not reached the standard of Cornell University in graduate study and specialization, but the governors of McGill University are going to encourage research work in agriculture, which is a great advance. We are getting demands from the Dominion Department of Agriculture and other institutions for experts, research men and teachers, who shall be better trained and better able to work independently on particular problems. We also feel that those engaged in teaching should be not only well grounded and know their special subject, but also be able to teach it, and hence we are paying more attention to pedagogical aspects, and have also endeavoured to teach the writing of articles for newspapers.

Such visits as those of our friends are most acceptable for bringing inspiration to this work and for giving the students an opportunity of hearing men distinguished in the fields of Plant Pathology and Entomology.

The "Pièce de Resistance" of this evening's programme is the address by Professor Whetzel, so I shall say no more, except to again welcome you very heartily.

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## PRESIDENT'S ADDRESS

# THE STORY OF SPRAYING MIXTURES

W. Lochhead, Professor of Entomology and Zoology, Macdonald College, P. Q.

Prior to 1860 the methods of protection of plants from insects and fungous diseases were extremely crude and primitive. Practically nothing was known about the nature of fungous diseases, and although insects had been studied for many years, no serious attempt had been made to control the injurious forms with chemicals. The best insecticides in use were various forms of soap, tobacco, quassia chips, carbolic acid and hellebore.

As we all know, spraying mixtures are of two kinds :— *Insecticides* and *Fungicides*, but some mixtures, like lime-sulphur and soluble sulphur, belong to both groups.

### Insecticides

In the development of insecticides, as of other phases of economic entomology, the United States has taken the lead over all other nations. Two outstanding factors contributed to this wonderful progress :—1. The losses which certain portions of the country suffered at various times from (a) the potato beetle ; (b) the Rocky Mountain locust ; (c) the cotton caterpillar ; (d) the San José scale ; (e) the cotton-boll-weevil ; (f) the Gypsy and Brown Tail moths, brought public opinion to bear strongly upon Congress so that measures were taken to discover methods of control ; 2. The establishment of State Agricultural Colleges and Experiment Stations which made it possible to train men for the investigation of such problems.

It is interesting to note that, in the matter of insecticides, methods of fumigation with hydrocyanic acid gas, and spraying with lime-sulphur and resiny washes were developed first on the Pacific Coast, while arsenical sprays and mineral oil preparations were developed in the East.

*Paris Green.*—Paris Green was the first insecticide of merit to be employed against biting insects. During the sixties, it came into use against the Colorado beetle, in the seventies it was successfully used against the cotton caterpillar and against canker-worms and the codling moth in orchards, and in the eighties against the plum curculio and other pests. By 1890 Paris Green had become the standard insecticide against biting insects. However, this and other arsenite compounds, like London Purple and the Kedzie mixture made from white

arsenic, were soon found to be unsatisfactory on account of their liability to burn foliage unless great care were taken to neutralize the free acid present.

*Arsenate of Lead.*—In 1892, Arsenate of Lead was first employed against the Gypsy moth, and gradually gained favor as a substitute for Paris Green. It has the advantage of being harmless to foliage, of remaining well in suspension without constant stirring, and of sticking to the foliage for a long time. It can, moreover, be used with Bordeaux and lime-sulphur as a combination spray. As the paste form deteriorates on exposure, while the powder is quite stable, the latter is recommended for general use.

Sanders and Kelsall, of the Dominion Entomological Laboratory, Annapolis, Nova Scotia, have done some admirable work on the reactions that occur when arsenate of lead is mixed with other chemicals. For example, they found that apple foliage is liable to be injured when more than 15 mgms. of $As_2O_5$ are in solution per 1000 cc. of water. In the case of lead arsenate (PbH $AsO_4$) it is seldom soluble to the extent of 4 mgms. of $As_2O_5$ in 1000 cc., and on the average about 2 mgms. However, when the manufacturer adds a small amount of MgO to make it float better in water, a chemical reaction occurs which makes it dangerous to leaves. Magnesium arsenate (Mg H $AsO_4$) is formed, which dissolves to such an extent in water that 40 or 50 mgms. of $As_2$ $O_5$ are to be found in 1000 cc. of water.

Again, when a very small quantity of lime is added to lead arsenate, a lime arsenate (Ca H $AsO_4$ is formed which is highly dangerous. But if the lime be present in large quantities $Ca_3$ ($AsO_4$) is formed which is not dangerous.

*Arsenate of Lime.*—During the last two or three years, arsenate of lime has been employed by many growers as a substitute for the lead arsenates, on the score of reduced price and higher poison content, pound for pound. It is, however, less stable, but with the addition of a stabilizer such as hydrate of lime, Bordeaux, lime-sulphur, or soluble sulphur, when excess lime is present, it is quite safe to foliage.

For the coming year arsenate of lime is being widely recommended as a cheap and effective substitute for arsenate of lead.

*Lime-Sulphur.*—Perhaps the most outstanding achievement in commercial spraying during the last forty years has been the introduction and improvement of lime-sulphur. In the eighties the California fruit growers used it against both the scale and the peach leaf curl. As an insecticide against scale and many sucking insects, it has been employed ever since, but, by the early method of preparation, it had to be applied warm for crystals soon formed, which tended to

clog both the spray pump and the nozzles. Moreover, it could be used only for the dormant or semi-dormant stage.

About 1912, a new method of preparation was discovered, which removed the objectionable features of the old method. It consisted in making a concentrated solution by boiling together 50 lbs. of fresh stone lime, 100 lbs. of sulphur and 40 to 50 gallons of water.The solution when properly made can be kept for months, and for use can be readily diluted to any strength required for dormant and summer spraying.

The discovery by Sanders and Kelsall of the cause of the heavy drop of the fruit after applications of lime-sulphur is worthy of note. They found that when lime-sulphur (1 to 30) was applied only to the upper surface of the leaf no injury followed, but when both sides, or only the lower surface were sprayed, injury was done. When sprayed leaves were examined miscroscopically it was observed that the chlorophyll of the leaf-cells had been acted upon by an appreciable amount of lime-sulphur absorbed through the lower surface. They observed, however, that no such injury followed applications of Bordeaux and soluble sulphur.

The excessive dropping of the fruit, they maintain, is due to the injury to the leaves whereby they fail to function as carbohydrate manufacturers for the fruit. The greatest drop occurs after the fourth application, that is, the one given two weeks after the petals fall, and has only become evident since the advent of high-pressure pumps and greater capacity nozzles.

Another important investigation by Sanders and Kelsall bore on the question of the influence of fungicides on the killing value of poison insecticides when the two are mixed together. They found that with Bordeaux the average poison is decreased in value by about 50 per cent. With soluble sulphur, the value of the poison is increased from 10 to 15 per cent, and with lime-sulphur the decrease is about 20 per cent.

*Kerosene Emulsion.*—A solution of Kerosene Emulsion has long been a valuable insecticide against sucking insects. The standard formula (Riley-Hubbard) was originated in 1884, although several modifications have also appeared. When properly prepared Kerosene Emulsion can be applied with safety on most plants, but of late years tobacco extracts have taken its place.

*Tobacco Extracts.*—Tobacco dust and extracts have been used probably for more than a hundred years for the control of aphis and other sucking insects, but it is only within the last ten years that concentrated extracts of nicotine have been placed on the market. The best known of these are "Black Leaf 40", being a 40 per cent solution of nicotine sulphate, a non-volatile substance, and

"Nicofume", a 40 per cent solution of nicotine in the volatile form. Black Leaf 40 can be combined with lime-sulphur, Bordeaux and arsenates of lead and lime as a 3-in-1 mixture, and is used at strengths varying from 1 to 800 to 1 to 1600 of water.

## Fungicides

It is not surprising that plant growers of two or more generations ago had difficulty in controlling plant diseases, since the nature of these maladies was not understood. One has but to peruse some of the old works on the nature and treatment of disease to find how crude were the conceptions of the early plant growers and botanists, and how far the modern plant pathologist has travelled during the last fifty or sixty years.

Three outstanding factors contributed to the great development of our knowledge of plant diseases and methods of control :

1.—The epochal investigations of European botanists on the causal organisms and their relation to such plant diseases as smut (1853), the potato-rot disease (1861), and wheat rust (1865).

2.—The rise of American investigators in the seventies and eighties, such as Burrill, Farlow, Arthur, Bessey, Halstead, Earle and others whose contributions added substantially to our knowledge of fungi and of fungous and bacterial diseases.

3.—The work of the U. S. Department of Agriculture and of the newly established Agricultural Colleges and Experiment Stations which gave a tremendous impetus to the study of plant diseases and control measures from 1885 onward to the present.

It is true that sulphur and powdered lime were often dusted upon the plants and gave some relief, but it is only since the discovery of Bordeaux in 1883 that the control of plant diseases has been carefully investigated. The plant pathologist has shown clearly that the fungicide should be applied just before the rain, not after. In the case of apple-scab, for example, the spores are carried to the leaves during rains, and if the rainy spell lasts 48 hours infection will take place. To protect the leaves, therefore, the spray must be applied before the rain.

Again, the plant pathologist has shown clearly that a knowledge of the life history of the fungus is essential if best results are to be secured in spraying operations.

*Lime-Sulphur.*—Lime sulphur has already been mentioned among the insecticides, but it is also one of the best fungicides. For a time after the discovery of Bordeaux mixture it was discarded, but in 1906 its importance as a fungicide was rediscovered, and ever since it has been employed extensively for the control of many fungous diseases of the orchard.

In Nova Scotia, however, the fruit growers observed that the calyx spray and especially the following spray were responsible for a heavy fall of fruit on account of its action on the leaves. For this reason they substituted in 1918 and 1919 a modified Bordeaux for the lime-sulphur.

Lime-sulphur is in the main a mixture of polysulphides of calcium. The fungicidal properties of lime-sulphur lie in the free sulphur that is formed on the surface of the leaves and fruit on the evaporation of the water and the oxidation of the polysulphides.

When trees have been drenched with the mixture, injury is liable to occur, but under proper conditions little or no injury follows, except in the case of potatoes, American grapes and some varieties of peaches.

*Bordeaux Mixture.*—From the time of its discovery by Prof. Millardet, of France, in 1883 up to 1910, Bordeaux mixture was the standard fungicide for summer spraying. But with the rediscovery of lime-sulphur in 1906 as a summer spray, Bordeaux has been relegated to second place in commercial orcharding on account of the russetting of the fruit and the yellowing of the foliage that followed the standard application, made according to the formula 4:4:40.

The stucture and composition of Bordeaux mixture has been recently ascertained. It consists of colloidal membranes composed of a complex mixture of basic copper sulphates, enclosing a solution of calcium hydroxide and calcium sulphate holding lime particles in suspension. The fungicidal properties depend on the number and size of the colloidal membranes and on the lime particles. The smaller the membranes, the more effective does the mixture cover the sprayed surface. When evaporation of water occurs, the minute membranes dry down and attach themselves firmly to the surface. Then the copper in the membrane is slowly dissolved when the leaves become moist, and either kills or inhibits the germinating spores which lodge on the leaf. Moreover, it is believed that the lime particles are also fungicidal.

It will be seen, therefore, that the quality of the Bordeaux depends upon the method of preparation.

The minute membranes will never be formed when concentrated solutions of Copper sulphate and milk of lime are brought together. On the other hand, they will be formed when vigorous stirring takes place when the dilute solutions brought together.

Reference has already been made to the peculiar conditions in Nova Scotia, which compelled the fruit growers to return to a modified form of Bordeaux where lime is used in excess. In 1919 they used the 3 :10 :40 and the 2 :10 :40 formulæ with gratifying results.

## Dust Spraying

While dust spraying was probably employed before liquid spraying, it was superseded by the latter when Bordeaux mixture and Paris Green became the standard spraying materials. However, as fruit growing was developed more extensively, and intensively as well, the factors of economy of time and cost of equipment in spraying operations assumed more importance, and efforts were made by the more progressive men to meet the needs of the industry by devising more economical methods of spraying.

About 20 years ago sulphur dusting was tried occasionally on grapes, but about 1911 orchard experiments in dusting were begun in New York State by Cornell Station. These were continued for about seven years or until it was conclusively demonstrated that dusting was both efficient and practicable, and a satisfactory substitute for liquid spraying.

Nova Scotia furnishes an interesting example of changing methods in spraying, due to the investigations by Messrs. Sanders, Kelsall and Brittain. These gentlemen have devised improved mixtures for both liquid and dust spraying. Up to 1912 Standard Bordeaux was the fungicide used by the fruit growers ; then lime-sulphur was substituted. When this proved unsatisfactory a modified Bordeaux with an excess of lime was employed.

Dusting was introduced about 1916, and gradually made headway with improvements in the manufacture of dust products. In 1918, 1919 and 1920 the 90-10 sulphur arsenic dust (90 per cent sulphur and 10 per cent lead arsenate) and copper arsenic dust (10 per cent copper sulphate, 5 per cent arsenate of lime, and 85 per cent hydrated lime) were used. In 1921 both the sulphur and the Bordeaux methods will be used by the fruit growers of that province.

Up to 1920 no dusting material has been found that controlled sucking insects satisfactorily, but the 1920 experiments in California against the Pear Thrips, with 5 per cent "Nico dust" which contains 5 per cent Black Leaf 40 and pulverized Kaolin, and those in Nova Scotia against psyllids with nicotine sulphate with sulphur and arsenate of lead, give strong hopes that the difficulty has been largely overcome. It will be possible for the future to use a 3–in–1 combination dust against fungi and biting and sucking insects.

In this very incomplete review an attempt has been made to make clear the chief outstanding events in the story of spraying mixtures. These are :—

1.—The use of Paris Green against biting insects, between 1860-1870.

2.—The introduction of Bordeaux mixture as a fungicide, about 1885.

3.—The introduction of lime-sulphur, first as a contact insecticide and later as a fungicide in 1906.

4.—The use of lead arsenate and calcium arsenate as insecticides against biting insects.

5.—The use of Kerosene emulsion and tobacco extracts as contact insecticides.

6.—The practicability of combining the more important insecticides and fungicides in one mixture for spraying purposes, thus saving much time in spraying operations.

7.—The manufacture of spray materials in finely powdered form and the introduction of dust-spraying, making for much saving of time.

8.—A better knowledge of the chemical reactions that occur when different spraying materials are brought together, and of the physiological action of these mixtures on the leaves of plants.

9.—A better knowledge of the life history of insects and fungi, so that the spray applications are made at times when they will be most effective. In other words, the spray calendars are now based on the stage of development of plant, insect and fungus, and not as formerly on the almanac.

10.—Closely connected with developments in spraying is the development of spraying outfits, which this paper does not attempt to discuss.

In conclusion, it is a pleasure to note the part taken by Canada in the story of spraying mixtures, although she has in most cases followed the lead of the United States and Europe.

Mention has already been made of the splendid investigations carried on in Nova Scotia by Sanders, Kelsall and Brittain in connection with lime-sulphur injury, and with the making of dust mixtures, but credit should be given to Saunders and Reed, of London, Ontario, for their early experiments (1871) with various chemicals for the control of the potato beetle, to Cline, of Winona, and McMichael, of Waterford, for their experiments with orchard insecticides and fungicides from 1883 to 1887, to Prof. Craig, of the Dominion Experimental Farm, for experiments on the control of apple scab and other diseases with Bordeaux and other fungicides (1890-1894), to Dr. Fletcher for his experiments on the control of many injurious insects, and to the Ontario Agricultural College for experiments with lime-sulphur and other substances against the San Jose scale.

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## REPORT OF THE DELEGATE TO THE CANADIAN BRANCH OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

Prof. B. T. Dickson

The second annual meeting of the above Society was held in the Biological Building of the Ontario Agricultural College, on December 9th and 10th, 1920. There was an excellent attendance of members from as far west as Saskatoon and east from Montreal.

Dr. Buller, of Winnipeg, was in the Chair, with Dr Reddick, of Cornell University, as the Society's guest.

The President, in an able address, discussed the losses which constituted an annual tax on the growers and cited specific statistics in the case of the most important diseases.

Dr. Reddick, in a public evening address, showed that most of the great results in plant pathology were the outcome of quiet, thorough research. These were then applied to the practical side of the science, so that benefits accrued, but in most cases those who thus benefitted knew little or nothing of the pioneer research. The science is still a young one, but much good work is being done and there are plenty of fields of endeavour for the future. It is of prime importance, however, to look carefully to the training of those who are going to undertake the work that only the best may be done.

Prof. Dickson gave an illustrated paper on mosaic diseases, dealing with the list of plants at present known to suffer from mosaic. This included clovers, potato, tomato, tobacco, violet, etc. It was pointed out that symptomatically raspberry is a member of this list and it is possible that, in the past mosaic and curl, or yellows, have been confused. Histologically also this type of raspberry disease falls in the mosaic class. It remains to be seen whether curl is an advanced stage of the raspberry mosaic. Work is in progress at present on that problem.

Prof. Fraser reported the work done by himself, Miss M. Newton and Mr. Bailey on biologic forms of the black stem rust of wheat in Western Canada. Using Stakman's method and tabulation strain IX is found at Saskatoon, XV in one locality, XVII mostly in Saskatchewan, XVIII at Riverstone, Saskatoon, etc., XXI at Winnipeg, Brandon, Edmonton, etc. Strain XV attacks all differential hosts. Kanred and Emmer are resistant to XVII and Marquis is resistant to XIX. It is not intended that this be considered a full report of Prof. Fraser's paper.

A new disease of strawberry was described by Dr. Stone as a Mollisiose. It has occurred during the last two years in Ontario from Sarnia to the east and is most prevalent on Clyde and Glen Mary varieties. Senator Dunlop and New Williams are both free from this disease.

It is symptomatically called "leaf scorch," owing to the effect on the leaves. At first minute purplish spots 1-6 mm. appear and later they enlarge and coalesce. As the disease progresses they become ashy colored and acervuli develop. Elongated purple spots also appear in the petiole.

Systematic studies show that the ascogenous stage is *Mollisia earliana E. and H.* The fungus overwinters on green mulched leaves and the ascospores are disseminated from April to June.

Control is possible by destroying old, diseased leaves and by spraying with Bordeaux.

Prof. Howitt gave a comprehensive account of three years' work on the dry formaldehyde treatment against oat smut. He found little injury to germination except in old oats with impaired vitality. In 1918, 61 bushels were treated resulting in treated plots being free from smut while check plots had 8.6% smut.

In 1919, 600 bushels were treated giving a negligible amount in treated plots as against 6.3% smut in untreated seed.

In 1920, 1016 bushels were treated and divided into 30 widely scattered trial plots. The results varied since check plots showed none to 14% smut.

The results are entirely satisfactory and especially when one considers speed of application. One hundred bushels can be treated in 50 minutes. In one instance oats were kept three weeks after treatment without injurious effects.

Dr. Rankin and Prof. Fraser reported on the work of the Plant Disease Survey for the year. Requests for collaboration and individual reports were sent to all likely to be interested, but unfortunately the number complying was small. Many areas were, however, well covered and from these conclusions can be drawn. It is hoped that during the ensuing year better results will be achieved. The Society expressed its appreciation of the work accomplished in so short a time by Dr. Rankin and Prof. Fraser and they were reappointed a Committee in charge for 1921.

Dr. Buller gave three illustrated and interesting talks. In the first he detailed experiments he had carried on to show that slugs were attracted to and carried spores from certain members of the Phalloideae.

He also discussed the phenomena of spore discharge in the Discomycetes, explaining that this discharge is audible if the Discomycete be held close to the ear.

Mr. Duff dealt with the development of the fruit body in the Geoglossaceæ and illustrated his talk by blackboard diagrams.

Dr. Faull delivered a very interesting talk on *Fomes fomentarius*, explaining how it could be cultured in the laboratory and giving a detailed account of the pathological effect on the host trees.

Prof. Caesar made a strong plea for more extension work, maintaining that we did not need so much research to-day as we did need the dissemination among farmers and fruit growers of the facts made known during the last ten years. Prof. Cæsar explained that he did not intend to imply that research should cease.

The Society closed a useful and interesting session with the following officers for the year 1921 :—

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| President | J. H. Faull. |
| Vice-President | W. H. Rankin. |
| Sec.-Treas | R. E. Stone. |
| Councillors | A. H. R. Buller. |
| | B. T. Dickson. |

The official program is appended.

### Thursday—December 9th

Meeting of the Council—11.00 a. m.
President's Address—2.00 p. m.....A. H. R. Buller.
Appointment of Committees
Studies in Mosaic (Illustrated).....B. T. Dickson.
Biologic Forms of Wheat Stem Rust in Western Canada....Margaret Newton.
Biologic Forms of the Wheat Stem Rust in Western Canada.....W. P. Fraser.
Leaf Scorch or Mollisiose of the Strawberry.....R. E. Stone.
Results of Three Years Experiments with the "Dry Formaldehyde Method" of Treating Oats for Smut.....J. E. Howitt.

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### Evening Programme

Address of Welcome.—President J. B. Reynolds.
The Trend in Plant Pathology.—Dr. D. Reddick.

## Friday—December 10th

Election of Officers—9.00 a. m.
Report of Committees.
Appointment of Committees for Coming Year.
General Business.
Report on the Plant Disease Survey.....W. H. Rankin, W. R. Fraser.
Upon the Chemotactic Attraction of Fungi for Slugs (Illustrated).....A. H. R. Buller.
The Sound Made by Fungus Guns and a Simple Method for Rendering Audible the Puffing of Discomycetes (Illustrated).....A. H. R. Buller.
Development of the Geoglossaceae.....G. H. Duff.
Studies in Fomes fomentarius.....J. H. Faull.
Relation of Plant Pathology to the Farmer and Fruit Grower.....L. Caesar.
Upon the Ocellus Function of the Subsporangial Swelling of Pilobolus (Illustrated).....A. H. R. Buller.
Observations of Interest to Plant Pathologists.....Members of the Society

## THE PRESENT STATUS OF PLANT PATHOLOGY IN AGRICULTURE

By Professor H. H. Whetzel, Cornell University.

*Mr. President:*

I am not accustomed to this kind of introduction in New York, the state where I have lived so long, and naturally I appreciate the good things the Chairman has said and the kind welcome Dr. Harrison has given us. I am sure Cornell has very kindly feelings for her Canadian students. We have had a large number of them. A Canadian, Dr. Schurman, who has just recently retired, guided the destinies of the University for a good many years.

When I promised to come down to talk to you, I said to my friend, Professor Dickson, that I would not agree to prepare a paper, so I can only say that you will not get an address, but merely a talk. I have been called upon to prepare so many papers this year, that I have rebelled and will not write any more.

My subject naturally interests me. A man ought to be interested in his profession, and not only interested in it, but he should "boost" it. If he is not in that frame of mind, he is in an unfortunate position for the profession and he is out of place.

I shall indicate briefly what I believe to be the position of plant pathology at the present time in agriculture, and shall also suggest, if I may, my ideas as to the future of plant pathology in agriculture, because if a man has no vision, he cannot be very much in love with his profession.

In the first place, I should like to touch on the historical side of plant pathology and briefly outline some of the important features as far as they relate to this talk. Modern plant pathology—I am not going back to the time of the Romans—began approximately in the middle of the 19th Century. American plant pathology began about 1883—or say 1880. The history of plant pathology on this continent is, in many ways, detached from the history of plant pathology in Europe. To be sure we drew our inspiration and to some extent our general outlook from those who there laid down the first principles, but American plant pathology has been characteristically American.

American plant pathology may be divided into two rather distinct periods. From 1883 until 1906 we had very rapid developments in the science along two lines. In the first place when the early plant pathologists began to investigate, they found before them a great variety of diseases. They attacked those nearest at hand and whatever they did yielded new facts, new information, because

it was the pioneer period. The diseases were often different from those in Europe or manifested themselves more destructively. The introduction of imported plants from Europe, the distribution of the agricultural flora, etc., all combined to make America an interesting field for plant pathologists.

Another feature affecting the point of view is that these men were trained as mycologists—they had come under the influence of De Bary and others and so followed along those lines in this country. Those men in Europe wrestled with problems of plant diseases to be sure, but particularly the mycological phase of the problems. One—Millardet –in France, experimenting in plant disease control, discovered Bordeaux mixture, and this was the beginning of the economic development in plant pathology.

This discovery is of interest because it led to the second line of development of plant pathology in America. America came very early into contact with Bordeaux mixture. Shortly after the outbreak of the grape mildew in Europe, there came to the United States Department of Agriculture at Washington, a French pathologist to study the disease over here, and it happened that the Department had at that time a number of young men who had begun to interest themselves in mycology. The cultivated vine in this country had also been attacked and these men began experimental work with Bordeaux mixture. This was the beginning of economic plant pathology on this continent.

The economic side was stressed from 1883 to 1906, and the study of plant pathology was taken up by mycologists who gradually became known as pathologists. Even at the present time very few men have been trained as plant pathologists. I was trained as a mycologist. It is true that in Experiment Stations they were given the title of "plant pathologist", but they were, for the most part, mycologists. The trouble was that plant pathology was not recognized then as a definite science. There was no chair of plant pathology in any university in the States. There was, however, a chair of plant pathology in Asia—in a Japanese University, about a year before the one at Cornell was established. Plant pathology was taught in courses, but an examination of any of these courses would make it evident that it was a course in mycology, so that the development of our science in most of our universities was strongly mycological, necessarily so because of the training of the men who worked in this field. It will be a generation yet before the men who determine the trend of plant pathology will be real plant pathologists. The thing that determines whether a man is a plant pathologist or not is his *point of view*. A man may work out the control of diseases in plants and still not be a plant pathologist.

Plant pathology is not a fundamental science. I am not sure that it is a science—among friends; I can admit that there are two sides to the question—but it is perfectly true that plant pathology is built upon other sciences. It is an

applied science. It has not come to be an art yet ! Chemistry, botany, physiology, histology, cytology and bacteriology are all fundamental to it and we require our graduate students to study them, as a good knowledge of these fundamentals is necessary for the practice of plant pathology. Plant pathology, therefore, is an economic or an applied science, and this puts us in the position to consider its relations to the subject of agriculture.

The history of college instruction in agriculture is very interesting. I want to point out to you the divisions into which agriculture was divided when it first came into our colleges, namely, chemistry, botany, animal husbandry, etc., and also that most directors of agricultural colleges were at first chemists, for chemistry was at first one of the most important divisions in our colleges of agriculture. Then we began to have departments such as agronomy or fieldcrops, horticulture, floriculture, pomology, etc. The evident trend now is to go back and recombine departments along the old fundamental science lines.

Plant pathology is generally looked upon in most agricultural colleges today as a division of botany. Perhaps it was best at first to have plant pathology a part of the general department of botany, but the conditions under which the work developed at Cornell were not such as favored keeping it in the department of botany. In the College of Agriculture at Cornell the department of plant pathology was a development from that of botany in the University. It was at Cornell that plant pathology had its first separate chair in an American University.

Now perhaps I can best illustrate the position of plant pathology in agriculture by using my own state as an illustration. You will pardon me for bringing my own experience in by way of illustration, but naturally no one else has developed plant pathology as I think it ought to be, and naturally I have to use my own State !

It seemed to me from the beginning of my work that since plant pathology is an applied science—an economic science—that it must "deliver goods" of that kind : that it must serve the economic field, and naturally that field is the agriculture of the state or nation, and those lines directly associated therewith It has generally been held to be true that the first obligation of a plant pathologist of a college was to the farmers and nobody else. I never could quite subscribe to that narrow view. The plant pathologist of the state should serve any citizen of that state who had a phytopathological problem to solve on his land, garden, front yard or even manufacturing establishment. All citizens pay taxes and, therefore, all men who have plant pathological problems have a call on his services. So that in developing plant pathology in a college of agriculture, the service should be carried to all who may legitimately claim it.

When I came to Cornell University one could buy stock in plant pathology for almost nothing. To illustrate, on one occasion I had to address a company of farmers on a pathological subject, along with a leader of the Farmers' Institute, and I got from him scant encouragement. I took for my subject "Fire Blight", and as I was young and enthusiastic, I carried with me considerable impedimenta, such as a lantern, slides, and a microscope. When I timidly suggested to the leader that I should have a place where I could exhibit my wares, I was told that the farmers would not understand me. (This was in 1903 when I was assistant in botany.) However, I secured a table where I set up my microscope and I was very much encouraged to find that the farmers did respond to the things in which I was interested.

I desire now to give you some notion of how plant pathology has "sold" itself in the State of New York. In 1906, when I was made assistant professor and head of the department, I had one assistant, a stenographer and $300 for all overhead expenses. At that time all field work and travel done by the departments at Cornell was paid for from appropriations given by the state or federal government. It always hurt when I had to spend money out of my grant to go and visit a sick geranium. I could not keep within the allotted appropriation and do all the work there was to be done. Gradually my work developed and was carried into the fields and orchards. I simply had to have more money to meet the demands for research and extension work. Then I got a little encouragement from my director. I suggested that the growers be asked to pay expenses for requested visits to inspect their fields and orchards. He was always lenient with my wild ideas and gave his consent for me to try this. The response from the growers was prompt and encouraging.

In 1909 we became interested in lime sulphur as a summer spray. We had in the department a young man from Nova Scotia who was interested in apple scab. Wallace became interested in lime sulphur and did some preliminary experiments in orchards near Ithaca. I had no money to keep him and I saw that we were going to lose him. A manufacturer of lime sulphur finally offered money for continuing the work. After considerable effort I managed to put this proposition through. I suggested that as it was an economic problem, we should ask those who benefited to bear a portion of the expense. I went to my director and he said he thought it was a good scheme, but it was radical, and he asked me if I did not think I would get into trouble. However, he laid it before the Board of Trustees and I got my first Industrial Fellowship. A field laboratory was established—a laboratory in a grower's orchard. The grower furnished trees to work upon. If we destroyed a lot of apples, the grower could not claim compensation from the university. In other words the grower was willing to back our investigation. The Industrial Fellowship policy was established.

It is instructive to note where the objections came from against thus selling plant pathology to people. They did not come from the farmers, they came from my own colleagues in Cornell and other institutions. They said I would lose my job, but as yet I have n't. The point I want to make is that up to 1907-8 research in plant pathology in the average institution was generally pursued on the College or Experiment Station farm. If the pathologist went elsewhere then the grower was to be reimbursed, so to say, for allowing the plant pathologist to solve his problems. It was like a doctor paying a patient for allowing him to operate on him. In 1909 we had our first industrial fellowship, which brought to the Institution $1,000. Since 1909 we have had approximately $80,000 in fellowships. Last year we had about $20,000 for this purpose from the growers and commercial concerns of the State of New York. I think that plant pathology as an economic science— as a profession—will sell itself. It ought to return interest on the money invested in it.

This change in the attitude of New York State is rather remarkable, especially if you know the New York farmer, for he does not spend his money without thinking carefully. To have this happen in a conservative state seems to me exceptionally good proof that plant pathology does have a place in economic agriculture.

The development of plant pathology in America has been very rapid since the year 1906, but a different kind of development from that prior to 1906. The development of plant pathology as a profession in the universities beginning with the establishment of the first chair of plant pathology at Cornell University, is an acknowledgment of the fact that the science of plant pathology is a phase of agricultural education and the result has been very promising. The rise and development of the Phytopathological Society on this continent is good evidence that this science is a part of agriculture.

For a long time the entomologists had the stage and the plant pathologists were lost among the botanists. I think it is safe to say that the plant pathologists of the United States and Canada constitute now as well-recognized a group of scientific men as there is anywhere. I think that they are better known to each other. They meet together more frequently than some other groups and that in spite of the fact that the organization is very young.

What is the justification for this rise and development of plant pathology ? I think justification is found in the fact that the diseases of plants play an important role in crop production. The best evidence of this are the serious losses from plant diseases which occur every year. In ordering sweet potatoes for example—for every two sweet potatoes that are delivered on your table, one other has been lost to disease. For every six cotton shirts that you buy, one has been lost by disease in the cotton fields of the south. The losses from plant

diseases on this continent run into millions of dollars annually. This loss is an economic waste that does no one any good. The results of this loss mean the cultivation of more acres of land by the individual farmer to get the necessary returns. The consumer pays for many more potatoes, or shirts than he wants. The small amount of money that the middle man filches is paltry compared with what fungus diseases take out of the crops of the country. One great reason why plant pathology has come to be recognized is because of the tremendous losses which occur and the reduction in those losses which the development of plant pathology has been able to show. Plant pathology is one of the most important phases of agriculture, and it, with entomology, can probably give larger returns on money invested in it than any other line of agriculture.

What then is to be the future development of plant pathology ? Its study should not be confined to agriculture colleges. The tendency in large universities is to put it in with some other department, such as botany. Even the Rockefeller Institute has considered the development of a division of plant pathology. The importance of the science has come to be recognized and we are going to be flattered in the future. I am not thinking of the development in colleges and universities.

New York farmers are also paying this year $20,000 for the extension work of the plant pathologist and entomologist. It works out in this way. When, for instance, a group of apple growers want a special spray service, they go to the Farm Bureau Agent and tell him they want an expert to give them advice and look after the work for them during the growing season. The College has a standing offer to supply these men. These men are seniors or first year graduate students. Their salaries run about $150 per month, of which the college pays $50. They are picked men of the institution and are sent into the county as representatives of the departments of plant pathology and entomology. The farmers prefer to go to Cornell for their plant pathologists and that institution had twelve operating in the state last season. The farmers provide, in addition to $100 for salary each month, a Ford and pay for its maintenance. It is generally a six months' proposition, for they live among the farmers while giving their services. To help in this work the Weather Bureau makes special forecasts of the weather for us in certain sections.

It is interesting to note that these men who go to the farmers are not experienced men, but they are picked men of ability. After a special training of two weeks they go into the field. They have to make good with the farmers and they have to make good with us, and if they fail they cannot stay for graduate work. We sometimes have failures, but not many. Farmers are willing to pay as high as $200 a month to a good man who has had a year in the field.

I think we have demonstrated clearly that plant pathology can be "sold" to farmers in much the same way as veterinary services can be sold. We can do far more in extension work with the money that the growers put in than we can with State dollars alone. It is perfectly certain, I think, that should the State not give any money for the work, the growers would raise the necessary cash.

During the war, when so many students were away, the trouble was that we could not get enough men in order to spend money we had at our disposal. However, since then, the State of New York is getting many men, who have returned from the war, for this extension work : in other words, it is getting the best brains of the country at a time when the men are most vigorous and most willing to work—it is getting extra good service at a time when young men will work the hardest.

The State cannot continue to appropriate increasingly large sums, nor should the State spend more than a limited sum of money, in order to give service to the farmers. But you can *sell* to the farmers in the State of New York what you could not possibly *give* them. While most of the population of the State of New York lives in cities, yet the State treats agriculture very well indeed. It supports other agricultural schools as well.

A large number of fruit growers, packing houses and potato growers will in the future maintain plant pathologists. Already a large seed company in New York has taken on one of our young pathologists. "If you will come with us, they said, we will pay you a salary to keep our stock clean and pure but only on condition that you go to Cornell in the winter and get your Doctor's Degree. You spend the summer on our stock and the winter at Cornell. When you get your degree, we will make you a permanent place in our staff as our plant pathologist."

I have tried to give you very briefly my idea of the place of the plant pathologist in agriculture, and I thank you for your interest and attention.

## OUR WINGED ALLIES

**Dr. W. T. MacClement, Queen's University.**

Man has elected himself lord of creation, but quite frequently he is reminded that the vote was not unanimous. Several very considerable groups of animals show by convincing actions that they have no respect for man's claim, and that he must frequently demonstrate his power both to take and to keep what he desires of earth's products. The other forms of life which, with ourselves, are directly or indirectly parasitic on the plant world, may be arranged in ascending order in the form of a tree. The upper parts may or may not have arisen from the lower portions, but at any rate the arrangement indicates a gradually but not uniformly increasing complexity of structure, and advance in intelligence. But instinct, that mysterious half sister of intelligence, makes formidable the lower groups, and whether we consider it the inherited memories of the race, or specially implanted knowledge, it is an effectual substitute for both intelligence and education.

At the base of our tree of classification are the Protozoa, the simplest of animals, showing some 4,000 kinds of one celled creatures. Above them are the colonial forms such as the Sponges, about 700 kinds. Near and probably related are the Flatworms, 1700 kinds, and the Coelenterates, 3,000 kinds, of which several produce corals. Above these but showing some relationship in their radiate symmetry are the Starfish and Sea Urchins 3,000 species, and the Rotifers and Segmented Worms, 2000 species. Here we reach creatures having bilateral symmetry,—the Mollusks, 25,000 sorts of them, and the Crustaceans, about 6,000 kinds. On the same great branch above the Crustaceans are two groups, the Spiders containing perhaps 4,000 species, and the other, the most formidable order of animal life, the Insects, of which about 250,000 kinds are known, and this is believed to be not more than one fourth of the species now existing. Not alone in number of kinds but in numbers of individuals of each kind, is this the most threatening of contestants for the fruits of the earth. On another stem of our tree of life are the back-boned creatures, Fishes 13,000 kinds, Amphibians 700 kinds, Reptiles 3,000 kinds, Birds 10,000 kinds, and Mammals 3,500 kinds.

Among the different classes named, man needs to recognize his friends and his enemies. All will obey nature's prime law, and will struggle for an existence and in doing so will destroy more or less of the available food in the world. Which of these groups will be direct rivals of mankind, seeking the food which man himself requires, and on which of them can man depend for aid against these rivals, by attacking, killing and eating them? Of all the invertebrate groups we find only one which seems to threaten seriously man's rule and welfare. The

insects—by their wonderful physical adaptation to their surroundings, by their ability to reproduce themselves at enormous rates, by their prodigious appetites, and their power of withstanding, in some form, extremely wide ranges of temperature,— show themselves to be man's formidable rivals for the possession of the earth. It has become a commonplace to be able to destroy by a few shots, a great ship which is so far away as to be almost invisible, but man's victories,—even his partial victories,—over insect attacks, may be counted on the fingers of one hand.

One invertebrate group, the Spiders, stands as man's ally against the insects, and,—while as yet scarcely recognized as a friend,—works early and late in building and rebuilding its snares for the common enemy. The other invertebrates are of no economic importance, except the Mollusks and Crustaceans, which are eaten by man and those others which furnish food for fishes. The vertebrates may largely be accounted as allies,—the fish destroying enormous numbers of insect larvæ ; amphibians and reptiles, living almost entirely on adult forms ; while in the birds we recognize our very best friends, especially qualified to give us both gratification to eye and ear, and much needed assistance in restraining the swarming millions of insects. If the inactive toad or frog is worth two dollars per year to the gardener, what indemnity shall we fix for the nuthatch, creeper, and vireo searching our trees from roots to branch tip for eggs, larvæ, or winged insect, or the swallow and martin sweeping the galleries of the air and appearing at the nest every ten minutes with a new captive !

By glancing over the different groups of birds we may reach a better conception of the gratitude we should feel for these our allies, and the support and encouragement we should give them. In arranging birds in groups which show their relationships, we begin with those which make their homes and find food and safety in, or almost in, the water. The first group is that of the Pygopodes or Divers including Grebes, Loons and Auks. These are all fish eaters, although no doubt Grebes eat numbers of insects and larvæ in the fishless ponds in which they often raise their broods.

The second order of birds is that known as Longipennes or Longwinged Swimmers including the Gulls, and Terns. Many of these are insect eaters, especially Franklin's Gull which feeds on the worms, grubs and grasshopper enemies of our prairie farmers. The Black Tern also deserves its name of Sea Swallow from its habit of hawking over our marshes, and living to some extent on insect food. The Tubinares are haunters of the deep seas, tireless fliers and probably of no economic value. The Fulmars, Shearwaters and Petrels belong to the waters off our Atlantic Coast. The next order—the Steganopodes—includes the swimmers which have all four toes united by webs. These are the Gannets, Cormorants and Pelicans. All of these are fish eaters and some of them have been accused of injuring the salmon fisheries, but intelligent study

of the matter proves them to be beneficient through their destruction of worthless fish, and quite harmless under all ordinary circumstances.

The order Anseres includes what are commonly called the Waterfowls, and we must acknowledge our past and present debt to the Swans, Ducks and Geese as direct providers of food. A few of the ducks eat small fish and shell fish, but the enormous numbers of insects they destroy, especially in the larval stage, place them among our benefactors from this point of view also.

The deep water waders are called Herodiones, and include as common Canadian birds only the Herons and Bitterns. Bitterns are poor fliers and find safety by standing silently with mottled yellowish and brownish body, neck, head and long sharp bill quite erect. Among the reeds and cattails a sharp eye is required to distinguish this stick-like structure from the similar objects about. The bittern's food is frogs, snakes and fish, but certainly none of value. The Blue and the Green Herons also live on fish, batrachians and insects found in shallow open water.

The next order, Paludicolæ, comprise the birds which walk over the soft marsh borders of lakes, and ponds. Cranes are long as to toes, legs, necks and bills, while the Rails and Galinules, have long toes but very moderate legs and necks. Their food consists chiefly of the insects found about marshes, along with wild rice and other vegetable matter. The Sandhill Cranes quite frequently visit grain fields after harvest, and with the Rails are counted as game birds.

The Shore Birds, Limicolæ, have long been a favorite group with sportsmen, both for the pleasure afforded in hunting them and the very delicate flesh which they furnish. Their destruction has been extremely rapid in most species, because each new generation, coming south from their wilderness hatcheries, often within the arctic circle, learns wisdom only when their dense flocks have been decimated by the breechloader. These plovers, snipe, and woodcock live apparently on soft bodied worms and insect larvæ, found in or on the soil of waste lands and the margins of lakes and oceans. They are certainly harmless and may well be considered beneficial.

We now come to birds which make their homes, obtain their food, and raise their young with slight reference to bodies of water. The Gallinæ, or Earth Scrathers, are entirely land birds, unable to swim, and they get their food—insects and seeds—entirely from the soil. Our poultry yard is stocked with tamed *Gallus bankiva*, descendants of the red jungle fowl of India, and with turkeys of the species which ran wild in Texas and Mexico. To the farmer these birds are of great importance since their food consists of seeds, fruit and insects. Fortunately weed seeds and waste grain form the great bulk of their vegetable ration, while some of them, particularly the quail and turkey, feed largely upon

injurious insects. The Bob-white feeds freely of the potato beetle, wire worms, and cut worms, while hundreds of grasshoppers are consumed per hour as a flock of young turkeys traverse a meadow or pasture.

The next group is that called Raptores, including eagles, hawks, owls and vultures. Many other kinds of birds are rapacious, but no other are so well equipped for capturing and killing other birds as well as small animals, and even fish. In spite of their highly specialized beaks and claws, our Canadian hawks, with very few exceptions, are mild and beneficial birds, only one of our owls is persistently injurious, while in no part of our country are eagles or vultures a menace. The hawks known as the Sharpskin and Coopers or the Duck hawk and Pigeon hawk, are destructive of valuable insectivorous birds, while the Gyrfalcon kills large numbers of the grouse of the northern wilderness. The Great Horned Owl visits and revisits the poultry yard, carrying away even turkeys and geese, and, if these are not available, attacking any of the other birds of our woodlands. All the other hawks and owls live upon the vermin which are such pests to agriculturists. Mice, rats, moles, grasshoppers, beetles, crickets, spiders and frogs are their usual bill of fare, and in the capture of these they are very persevering and skillful. The false idea, born of ignorance, that the killing of hawks and owls is meritorious is an anachronism, and should be banished to that limbo which has finally received, we hope, the hunting of the wren, and other such cruel superstitions.

The Coccyges is a group in which are birds showing but few similarities,—the cuckoos and the kingfishers. The cuckoos are heard more frequently than seen, being fond of dense thickets of shrubs, from which their call is heard in the late springtime. They live upon insects, and deserve our protection because of their unusual courage in eating largely of hairy caterpillars, especially those which defoliate our trees. European cuckoos are parasites, dropping their unwelcome eggs into the nests of small birds, Canadian cuckoos seldom do this, but build their own nest and rear their young in the orthodox manner. The Kingfishers live on small fish, but do little harm except possible in streams planted with troutlings. Their food is mostly the coarse and useless minnows and perch which would certainly feed on the eggs of better fish.

The order Pici includes our carpenter birds the woodpeckers. Ignorance, and the hereditary barbarism which prompts us to kill, have made these birds the targets for that destructive combination—a boy with a gun. We now know that, with one exception, the woodpeckers are interested in a tree, only that they may relieve it of its insect parasites. The exception is the Sapsucker, which punctures the protecting cork covering of several kinds of trees, and leaves them open to fungus infection, after it has eaten away the cortex and cambium which in the spring are filled with sugar or starch. The perforations may form a girdle about the trunk, and quite often result in the death of a valuable tree.

The Yellowhammer or Flicker has taken to the ground and lives largely in the contents of anthills. The wooden homes of the woodpeckers are frequently accepted by other birds, after one season of occupancy by the builders. Bluebirds, swallows, flycatchers, and the small owls show their respect for the ability of the avian architects, and suggest to us their desire for a shelter which we may easily provide for them.

The order Macrochires have, as the name indicates, wings that are large in proportion to the weight of the body. The Nighthawks and Whip-poor-wills, the Chimney Swifts, and the Hummingbirds make up a group showing little similarity. The first two are known as goatsuckers, probably from their wide mouths, and habit of haunting pasturefields in the twilight. Their food, like that of all the other members of the group, is the insect life they capture while on the wing. The Hummingbirds take also the nectar of flowers along with their small insect visitors.

We now come to the last and largest order of birds, the Passeres or Perching Birds, containing nearly as many kinds as all the other orders together, and among them those best known and most important to man. Nearly all have calls for their mates and companions, and many produce distinctly musical songs, repeated at long or at short intervals. The Flycatchers differ from other insect eaters in their habit of watching for their prey and darting upon it from a prominent perch, to which they usually return again and again. Their food is commonly captured near the ground while flying, but wingless forms are not despised. These eminently useful birds are known to us as Phoebes, Peewees, Kingbirds, and such Flycatchers as the Crested, the Scissortailed, the Olivesided and several others. Some build their homes about houses and bridges, others in small trees in open fields, while others prefer the depths of the forest. Moths, caterpillars, ants, wasps, flies, crickets and grasshoppers make up their common bill of fare.

In Canada we have only one species of Lark, although it varies in shade and size. Those found in the forested districts of the east are large and dark, with strong plumage markings, while the prairie varieties are smaller and paler. The Horned Lark is about one half larger than the house sparrow, with grayish upper plumage, yellow throat with a black spot across the breast and a black horn-like tuft above each eye. It has a slight but sweet song in early spring, and is a valuable destroyer of weed seeds in the open fields from which the snow is disappearing.

The Crow Family plays important parts in almost all parts of the world and are prominent and well known birds. It includes the Raven, Crow, Magpie, and Jays in Canada. Ravens are plentiful near fishing villages in Western Nova Scotia, but avoid all evidences of civilization in the interior of the contin-

ent, retreating before the lumberman and prospector. The crows on the contarry thrive in agricultural districts. Magpies belong to the western plains while jays inhabit forested regions. All the family are fond of animal food. Ravens attack weak or sickly lambs and live largely on living or dead crabs, lobsters, and fish that may be exposed at low tide. Crows haunt the edge of the water for any kind of animal refuse, searching also the nests of smaller birds for eggs or young, and destroying in late summer enormous numbers of insects, grubs, mice and small reptiles. But they are practically omnivorous, and are hated by farmers because of their vicious habit of pulling up and eating the sprouting grains, and also opening and eating the ripening ears of maize. Jays live largely on acorns and beech nuts, but also take eggs and young birds from the nests, and in winter will steal any kind of grain, especially maize. It is as yet impossible to say on which side of our account with this family the debit lies, and it quite certainly varies with the district and the season. Their intelligence will prevent their suffering any loss which might excite alarm.

Our groups of Blackbirds, which also includes the clear voiced oriole, and the so-called meadow lark, comprise at least two distinctly harmful species. These are the bronze grackle which destroys the young of many musical and insectivorous birds, and the cowbird, which is entirely parasitic in the matter of rearing its young. By dropping its egg into the nest of some smaller bird, the cowbird usually secures for each of its offspring the entire industry of a pair of foster parents. The young cowbird, by its precocity, absorbs nearly all the food brought to the nest and soon pushes overboard the legitimate nestlings, which are thus all sacrificed for the sake of the one intruder. By a surprisingly acute instinct, the young cowbird deserts its misguided foster parents, and joins with the flocks of its own kind before the autumn migration. The red shouldered starling, the bobolink, the oriole and the meadow lark are favorites with all, destroying our plant and insect enemies and providing joyous bird music.

The Sparrow family includes the Grosbeaks, Snow Buntings, Finches, Crossbills, Redpolls, Siskins and Longspurs as well as Goldfinches and Sparrows, All have strong and mostly conical bills, that of the grosbeaks being clumsily large, while the tips are curved and crossed in the crossbills. They are all seed eaters, but feed their young nestlings with insects. All of the list, except goldfinches and sparrows, come to southern Ontario only as visitors during winter and spring and gather the seeds and fruits left uncovered by the snow. Many are bright colored, and a few,such as the Rosebreasted Grosbeak and the Purple Finch, have very pleasing songs. Excepting that illmannered immigrant—the house sparrow—the whole family is worthy of our protection and encouragement. The pine and the cardinal grosbeaks of the above group, and the scarlet tanager are among our most notable examples of seasonal plumage chan-

ges. The adult males in spring are brilliant in suits of red, which gradually change during summer to match the greenish yellows and browns of the female. The latter may well be considered as wearing a protective coloration, when we consider how seldom we see or recognize the females as compared with our familiarity with the males.

The family of Swallows should have our very special care. They eat nothing of value to man, but destroy enormous quantities of insects caught on the wing over pastures grainfields, ponds and farm yards. With a little encouragement they will form colonies about farm buildings. The purple martin takes very kindly to birdhouses placed on tall poles or on buildings, and their graceful flight and pleasant gurgling notes are among the most satisfactory associations of summer in town or country.

Waxwings wear perfectly fitting suits of quaker brown, but their well marked crests and alert attitudes, and particularly the white wing marks and the garrulity of the erratic Bohemian waxwing neutralize any suggestion of passivity. A small fraction of their food may be cultivated fruits, but by far the greater part consists of harmful insects and waste wild fruits. The Shrikes destroy some desirable small birds but this may be balanced by their attacks on mice, crickets and grasshoppers in summer and house sparrows in winter. Vireos or Greenlets are small greenish brown birds which live almost entirely on the insects which infest our trees, particularly the slender branches and leaves. Some of these inconspicuous friends of man may be heard singing almost continuously throughout the brightest and warmest hours of midday.

The Wood Warblers are in general small in size and wear brightly marked plumage. They are unknown to the ordinary unobservant person, but are worthy objects of delightful woodland walks to those initiated into the charms of bird study. An opera glass is required to make clear their markings and when the warblers can be recognized and named without a gun, the fortunate person may consider himself an amateur naturalist. They are all insect eaters, inhabiting groves and the higher parts of trees.

The most notable of our Canadian singing birds are the catbird and the brown thrasher. The former is smoky gray in color and usually sings from the shelter of a thicket. Its relation to the mockingbird is shown in its power of mimicry by which the songs of other birds are reproduced in clear melodious and continued strains. The thrasher sings usually from a prominent spray or the top of a small tree and its song rivals that of the catbird. Both of these birds live largely upon injurious insects and wild fruits,occasionally visiting the cultivated raspberries. Wrens require no description or introduction because their busy singing, scolding, insect catching lives are so often closely associated with our houses, outbuildings, and orchards. A box, tin can or broken flowerpot

may be made the centre of amusing and beneficial activity as well as most cheerful music if we will locate it in a reasonably secluded but accessible place. The marshwrens build many globular nests among the cattails, and sing delightfully as they rise in short flights. Nuthatches and chickadees are seen in southern Canada mostly in the late fall and winter, the former searching the trunks of trees, the latter the smaller branches, for insects or their eggs or cocoons.

Canadian thrushes are, with a few notable exceptions, shy birds of deep thickets, or evergreen forests, from which their ringing but liquid notes may be heard at sunset. Our robin and bluebird are the members of the family which have shown a decided preference for the vicinity of man's buildings and orchards. Here they gratify his eye and ear from early spring until forced by cold and hunger to migrate southward. The robin may become a nuisance where small fruits are raised for market, but almost all its annual activity is for the benefit and pleasure of its human neighbors, in whom it has such confidence. Nearly one half its food is known to be of insects and worms, and except for a few weeks the remainderis of wild fruits. Few of us can show so excellent a life record as these cheerful and tuneful allies.

## ADDRESS BY Mr. A. GIBSON, DOMINION ENTOMOLOGIST

Mr. Gibson gave a sketch of the various branch laboratories at Annapolis Royal, N. S., Fredericton, N. B., Hemmingford, Que., Vineland, Ont., Friesbank, Man., Saskatoon, Sask., Lethbridge, Alta., and Agassiz, B.C., and described the nature of the work carried on. He also sketched the work done in connection with Forest Insects and the European Corn Borer.

The address was illustrated fully by means of lantern slides.

## THE LARCH APHIS

By Dr. J. C. Chapais, St. Denis, Kamouraska

About the middle of June, 1920, while I was making my Spring inspection of the trees of my arboretum, which contains a few fine specimens of the American Larch (*Larix Americana*) (vulgo : *Epinette Rouge, Tamarack*), I thought that the new Spring growth of one of them had a strange appearance and, on looking at it more attentively, I found that part of the tips of the new twigs were loaded with a mixture of sticky honey-dew, of numerous specimens of large dark aphides provided with very long legs, and of quite a host of very lively tiny black ants. In this mixture the new Spring needles or leaves of the twigs looked rather sickly. I was, evidently, in the presence of a new insect, uterly unknown to me.

As I usually do in such circumstances, I decided to send a few specimens of the twigs bearing this mixture to Mr. W. Lochhead, Professor of Biology at Macdonald College, to get from him some information concerning this new and very strange looking visitor to my larches. As usual, Mr. Lochhead very willingly sent me his answer, which was that I had to deal with a larch aphis very probably *Lachnus laricifex*, Fitch, and that I would get more information on this subject if I could get hold of a bulletin of the Orono, Maine, Agricultural Experiment Station, entitled : "Bulletin 202—July—Aphid Pests of Maine : Food Plants of the Aphides ; Psyllid Notes." Following Mr. Lochhead's advice, I got the above mentioned Bulletin, written by Dr. Edith M. Patch, from which I have extracted the following information concerning what is, very probably, *Lachnus laricifex*.

In this Bulletin, Miss Patch, one of the best United States authorities on the Aphididæ family, gives some notes on various species of Aphides, one species found on ferns, ten species on conifers, besides six species of the genus Lachnus, a sub-family of Aphididæ amongst which was mentioned one which seems, very likely, to be the species found on one of my own larches. Miss Patch has this to say about it :

"*Lachnus laricifex*, Fitch. What is apparently this species of Fitch is not uncommon on the larch (*L. laticina*, Koch) in Maine. Packard (1890) quotes the original description, and records scattered individuals from Augusta, Maine. No figures have been published for this larch aphis in America.

Cholodkovsky (1899), however, figures a larch species, *maculosus* Cholodkovsky, which is certainly closely allied to the Maine material and may perhaps be the same.

"I have no authority for calling this species *laricifex*, except that there is nothing in the description of Fitch or others to preclude its identity with that species, and the habitat and what habits are recorded for *laricifex* agree with this Maine species. There is, so far as I know, no authentic specimen of *laricifex* for comparison."

I append here a short explanatory note concerning the genus *Lachnus* above mentioned :

"This is a large and wide-spread genus of Aphides or plant-lice, typical of the sub-family *Lachninæ.* They are characterized by the linear stigma and nearly straight fourth vein of the fore wings. Nearly all the many species have woolly-looking waxy exudation, whence the name."

I intend, if I find this aphis on my larches next summer, to send a few specimens of it to Dr. Patch for identification and comparison with the species that she has found on the Maine larches.

If I am right in my identification of what I am inclined to call my new entomological find, it would be classified as follows : CLASS, Insecta ; ORDER, Hemiptera ; SUB-ORDER, Homoptera ; FAMILY, Aphididae ; SUB-FAMILY, Lachninae ; GENUS, Lachnus ; SPECIES, Lachnus laricifex, Fitch.

## CHEMICAL INVESTIGATION OF SPRAYS

A. Kelsall

Most of our knowledge on the efficiency and action of insecticides and fungicides has been derived from actual field observations. That is to say, many materials have been tried and their action upon plant pests noted, and their action upon plant foliage noted. Following such methods there has, during the past many years, accumulated a vast amount of information on the use of many materials as insecticides and fungicides. The reason why certain materials act as they do is often imperfectly understood. Much light has, however, been thrown on this by the chemical investigations of numerous experimenters. In France and England the chemistry of Bordeaux mixture has been thoroughly studied, and much of our knowledge of insecticide arsenicals we owe to the chemists of the U. S. Insecticide and Fungicide Board. The greatest bulk of materials used in plant pest suppression, consists of compounds of arsenic, of copper, of sulphur and of nicotine. In this brief address, I will just touch on some of the salient points of these arsenic, copper and sulphur compounds, presenting some information which has been long known and some of more recent origin.

Commencing with arsenical insecticides, it may be stated that an arsenical to be an efficient insecticide for application to foliage, must possess the following qualifications :

1. It must be soluble in the digestive juices of the insect, otherwise it will not kill.

2. It must, as nearly as possible, be insoluble in water, or it will injure the foliage.

The insecticide which best fulfills these conditions is lead arsenate.

### Lead Arsenate

Lead arsenates have, in the past, been placed upon the market in three forms, or generally as some mixture of three forms.
These consist of the compounds :

$Pb\ H\ AsO_4$ di-lead arsenate.
$Pb_3\ (AsO_4)_2$ tri-lead arsenate.
$Pb_4\ (PbOH)\ (AsO_4)_3$ basic lead arsenate.

Of these three, all are satisfactory insecticides, but the latter two, owing to the smaller amount of arsenic they contain and to their more expensive nature, have been largely discarded, and manufacturers aim to produce the com-

pound $PbHAsO_4$. This compound is generally highly satisfactory and non-injurious to foliage. But there are some cases where foliage injuries, sometimes very serious, result. The explanation of these is to be found in the presence of impurities in the water used. Di-lead arsenate in pure water decomposes in the manner shown in the following equation :

$$3PbHAsO_4 = Pb_3(AsO_4)_2 + H_3AsO_4.$$

That is, there is a certain concentration of free arsenic acid, but this concentration in pure cold water does not exceed a few milligrams per litre of water, an amount entirely negligible.

If some impurities are in the water, the amount of water soluble arsenic may be increased tremendously. Thus ordinary calcium carbonate reacts in a manner which may be indicated in the following equation :

$$5\ PbHAsO_4 + 2CaCO_3 = Pb_4(PbOH)(AsO_4)_3 + 2CaHAsO_4 + 2CO_2 + H_2O.$$

The di-calcium arsenate thus produced is fairly soluble in water. This reaction may even be produced from the calcium carbonate adhering to the sides of a spray tank which has at some time contained lime.

If common salt is contained in the water a reaction follows which may be represented as follows :

$$5PbHAsO_4 + NaCl = Pb_4(PbCl)(AsO_4)_3 + NaH_2AsO_4 + H_3AsO_4.$$

Here again, large amounts of water soluble arsenic are liberated. Similar reactions occur with other water impurities, and consequently where $PbHAsO_4$ is used on tender foliage (I am speaking of its use unmixed with any fungicide) a fairly pure water is necessary. With impure waters the basic lead arsenate is much preferable, and this has been recognized for many years.

It is also very noteworthy that while $PbHAsO_4$ is unreacted upon by the carbon dioxide of the air, mixtures of $PbHAsO_4$ and lime are reacted upon precisely to the same extent as is calcium arsenate. It follows, therefore, that it is unnecessary to use the expensive $PbHAsO_4$ in mixtures containing excesses of lime, for calcium arsenate fulfills the same purpose.

## Calcium arsenate

The exact composition of commercial calcium arsenate is not known. Several calcium arsenates are known, most notably di-calcium arsenate $CaHAsO_4$ and Tri-calcium arsenate $Ca_3(AsO_4)_2$. Both these compounds are too soluble for spraying purposes. The commercial compound contains a higher proportion of calcium and is very insoluble,

As you all know, calcium arsenate can only be used on foliage which is fairly resistant to arsenic injury. Calcium arsenate, though very insoluble in water, is unfortunately reacted upon by carbon dioxide. Consequently, when exposed to the air a certain amount of soluble arsenic is produced, the reaction being of the following nature :

$$Ca_3(AsO_4)\ 2 + CO_2 + H_2O = 2CaHAsO_4 + CaCO_3.$$

That is to say, the more basic insoluble calcium salts are converted into the more soluble hydrogen salts. Naturally, in the presence of an excess of free lime the above reaction cannot occur, so that calcium arsenate is satisfactory in such mixtures which contain an excess of free lime.

## White arsenic

White Arsenic $As_2O_3$, is too soluble to permit its use on foliage. Mixed with lime, it forms calcium arsenite, $Ca(AsO_2)_2$, and this also, though a relatively insoluble salt is so readily decomposed that it is highly injurious to foliage. When added to Bordeaux mixture, however, white arsenic loses, under certain conditions, its injurious properties. The arsenic ceases to be soluble in water. Whether this is due entirely to chemical union or to absorption by the copper precipitate is not altogether known.

The use which can be made of white arsenic in Bordeaux mixture is obviously of considerable economic importance, and instructions have been issued by the Entomological Branch regarding its use.

## Bordeaux mixture

Any mixture of copper sulphate and lime is termed Bordeaux mixture. The composition of the copper compounds of Bordeaux mixture varies according to the relative quantities of copper sulphate and lime present. The compound present in the ordinary 4.4.40 Bordeaux mixture has the formula $10Cu0.S0_3.3Ca0$ together with free lime and free calcium sulphate. If more lime is present, then there is more lime in the molecule ; if less lime is present, then there is less lime in the molecule, and there exist lower basic sulphates of copper.

The compound $10Cu0.S0_3.3Ca0$, which of course has also a certain amount of water in its constitution, is typical of the compounds of Bordeaux mixture. This salt is insoluble in water and there seems little doubt that its fungicidal nature is dependent upon the solvent action of the fungus itself.

Although this compound is insoluble in water, yet after it has been exposed to atmospheric conditions for a considerable time, copper commences to make its

appearance in solution. If this occurs on such tender foliage as peach or apple, copper injury results. The decomposition of the copper compound may be represented somewhat as follows :

$$2(10Cu.0.S0_3.3Ca0) + 15\ C0_2 = 9(Cu0)\ 2.CO_2 + 6CaC0_3 + 2CuS0_4.$$

Thus free copper sulphate is liberated. It is apparent that this reaction cannot take place while any free lime remains in the spray film. For this reason large excesses of lime are necessary on tender foliage.

While discussing Bordeaux mixture, it is appropriate to mention the copper dust recently brought forward by Mr. Sanders, and which is being so extensively used in Nova Scotia. This dust is really a Bordeaux mixture. The novel feature being the use of the copper sulphate mono-hydrate, $CuSo_4H_20$. This form of copper sulphate is a fine white powder very suitable for dusting, while the ordinary blue copper sulphate, $CuS0_4.5H_20$, does not lend itself to the same purpose.

### Sulphur

Finely ground sulphur is extensively used for dusting, and has a fairly high fungicidal value. For want of more knowledge on the subject, it is assumed that the fungicidal action depends upon a slow oxidation of the sulphur to sulphur dioxide, $S0_2$, which material is known to have a powerful toxic action on all lower forms of life.

In order to reduce the cost, hydrated lime has sometimes been mixed with sulphur. When this is done, sulphur dioxide would be taken up by the lime, and it might be supposed the fungicidal value thereby lessened. However, with lime and sulphur in the presence of water a reaction occurs somewhat as follows :

$3Ca(0H)_2 + 4S = 2CaS + CaS_20_3 + 3H_2 0$ and soluble calcium sulphide is formed. Does this calcium sulphide have as high fungicidal value as the sulphur dioxide from free sulphur ? This is a point on which work is needed. Mixtures of sulphur and lime do have a definite fungicidal value, for many people use it with success. Our own experiments in Nova Scotia would strongly indicate that mixtures of lime and sulphur were inferior to free sulphur.

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## THE POTATO PLANT LOUSE

By Omer Caron, B.S.A., Assistant Entomologist, Province of Quebec.

When asked by a director to prepare a paper for this meeting, I decided to speak of a pest that gave me trouble the past year, since it raged in the district where I happened to be.

I feel that it will be somewhat difficult for me to interest a meeting of technical entomologists such as this one. For this reason I shall be brief and shall content myself with a discussion of some matters of a practical nature.

A few words regarding the Potato Plant Louse, called by the scientific name of *Macrosiphum solanifolii* :

This bug, with which the public is not very familiar, is not unknown to entomologists. In the United States it has been described at length and studied in those sections where it has done damage. The best descriptions help us but little however, to identify it, since it resembles very closely members of other species. The variety that interested me was the *green* variety. These plant lice, like others of the family, comprise winged and wingless, viviparous females, oviparous females and winged males.

My observations were made on the farm of the School of Agriculture, Ste. Anne de la Pocatière where I was in charge of potato spraying. The damage caused last summer was considerable. The plant lice attack by preference healthy and strong plants ; in a few days infested plants wilt, turn brown and dry up very quickly. It was evident that as a result the growth of the tubers was arrested. Happily the ravages of the insects did not extend very far beyond the limits of the farm, for an invasion of this kind is more to be feared than the ordinary invasions of the potato beetle. The latter can readily be combatted by the ordinary means, but in the case of the plant lice, a more complex treatment is necessary.

The plant lice are *sucking* insects and they do not feed on the upper surface of the leaves, but on the lower. It was necessary, therefore, in order to reach them, to use an apparatus directing a jet of spray on the under surface of the leaves, and as this operation has not been satisfactorily accomplished for Bordeaux applications, better results were not secured in this case.

The invasion of which I speak took place in the second part of the summer, that is about the 10th of August.

The plant-louse under consideration does not confine its attacks to potatoes ; when it is found near fruit trees, I have often met it on them. On fruit

trees applications of nicotine sulphate gave good results. This operation has perhaps not been put into practice in the case of potatoes, because the special spraying devices have been wanting.

Bordeaux mixture has not any noticeable action on these insects. In fields of potatoes lady bird larvae feeding on the plant lice are developed to a tremendous extent.

I do not think that we should be very much alarmed over this purely local appearance of these insects : it is well, however, to be acquainted with them so as to be able to take measures to arrest them in case of invasion, which is always possible.

In looking over the entomological literature of the United States, I note that several states, particularly Maine, have suffered from the potato plant louse. In all cases, the experts recommend applications of nicotine as the most effective, after trying out many other treatments.

I have thought well to note the above facts on account of the economic importance of its knowledge.

I shall listen to and read with pleasure any suggestions the members of the Society may offer on the subject.

## SOME METHODS OF SEED TREATMENT

By Georges Maheux, Provincial Entomologist, Quebec.

This is an important question since many diseases are seed-borne. It is easy to understand some of the advantages which would accrue to the agricultural world by protecting plants against important insect and fungous enemies. If one considers cereals alone, the growers of the province would save some $30,000,000 if all seed were treated properly before sowing.

The methods employed are very simple and do not require many hours of work successfully to carry them out. If they were generally applied, the sanitary condition of our crops would improve immensely. Two crops stand out in this respect because of their importance—oats and potatoes—and this is seen when one remembers that the value of these crops amounted in 1920 to over $100,000,000 in Quebec. It is to these that we must direct most attention and if one adds spraying with Bordeaux to seed treatment of potatoes, our efforts will bring almost complete success.

The present article deals with the most important methods of seed treatment and the arrangement is on a crop basis.

### I. CEREAL CROPS

Each year the fungous diseases of cereals increase in importance and especially is this the case with the oat smut and stinking smut of wheat. In some areas of Quebec loose smut of wheat is common, but generally stinking smut is by far the commoner. Occasionnaly one finds also covered smut of oats, and the smuts of barley. It must be remembered that while seed treatment is very important, it is not a panacea, and all other factors must be borne in mind : soil preparation, culture, choice of varieties adapted to the region and rotation.

The seed treatment most in favour to-day is the formalin treatment. One uses a concentration of about 1 in 300 and this is sufficient to kill the spores which adhere to the seed or glumes. There are several methods of procedure and each will be dealt with briefly.

*Immersio or Soaking.*—The grain is put in a sack and soaked in a solution of one pint of formalin to forty gallons of water for five minutes. This method has its disadvantages especially as the grains swell considerably and it is therefore necessary to sow carefully if the crop is put in immediately.

*Spraying or Sprinkling.*—In this method the same strength of solution is used, but the grain is spread out on a good floor and the solution sprayed or

sprinkled on the grain, which is shovelled well so that each grain receives a coating of the disinfectant. I must point out here that some farmers have achieved excellent results by sprinkling copiously. The disinfecting action of formalin is only completely realised when the vapor is produced and in order to ensure the effect of formaldehyde vapor on the grain it is necessary to cover it with sacking for five or six hours. Experiments made by farmers have shown that even if left covered for as long as twelve to eighteen hours there was no injury to the grain and the crop is healthy.

*Concentrated Solution.*—This is a recent method which has the advantage of avoiding the necessity of handling a large quantity of water. It is carried out by spraying with a concentrated solution consisting of one pint of formalin with one pint of water. This is sufficient for fifty bushels. The grain is shovelled well during the spraying and is then covered for several hours. For my part I prefer the previous treatment, because it has given the best results in our county demonstration experiments.

The treatment with formalin we owe to the work of Bolley, Swingle, Genther, Arthur and others, but it is not the only method in use. Before the use of formalin came into vogue and towards the end of the nineteenth century, Benedict Prevost had succeeded in controlling stinking smut of wheat by soaking it in a solution of copper sulphate. Mathieu de Dombasle verified the method but the growers, believing this substance to be very poisonous, continued to use a simple heating or sulphate of soda followed by heating. Kuhn again used the method and Linhart perfected it. The copper sulphate treatment is now the only one in use in Australia.

Among the diseases of cereals we find two in which the organism does not exist on the surface but lives over in the seed itself. These are the loose smut of wheat and of barley. In this case, therefore, formalin treatment is not applicable, but Jensen discovered that by careful treatment with hot water these diseases may be controlled.

*Hot Water Treatment.*—In this method it is necessary to work with a temperature which will kill the organism without affecting the germination of the grain. This is done by using three baths with a gradually increasing temperature as follows :

1. Soaking at 86° F. for 4 hours.
2. Soaking at 112° F. for 15 to 20 minutes.
3. Soaking at 129° F. for 10 minutes.

The first bath facilitates the heat penetration of the later soakings which are of much shorter duration because of the higher temperature. It is import-

ant to note that the last bath must not rise above 129° F. or injury to the grain will certainly occur.

### II. FORAGE CROPS

Corn smut does not occur extensively in this province and it usually suffices to destroy the smut boils when seen. The spores remain in the soil or are found in the manure and according to Howitt (Ont. Bull. 258) neither formalin nor copper sulphate treatments are efficacious.

Our growers ought always to protect maize against another enemy. In the beginning of summer our fields are invaded by crows which live upon the corn grains principally. It is necessary, therefore, to find some treatment which will prevent damage by crows, which will not be harmful to useful birds and which will not injuriously affect the embryo. There is a choice of two methods. The first and better consists in the use of tar as a repulsive agent.

1. *Tar.*—This is used at the rate of a soup-spoonful to a half bushel of corn. The grain is first placed in warm water and then drained. The tar is then sprinkled so that each grain is well covered. It is then left to dry, or is rolled in ashes, dust or plaster so that the grains do not adhere one to another. In normal years this treatment does not retard germination and only in very dry seasons does any injury to germination happen.

*2. Red Lead.*—Farmers, Bulletin 1102 advises the use of this substance which has given good results. The grain is dipped in dilute glue so that the powder will stick and the read lead sprinkled on it until it is well colored.

Others use petroleum, carbolic acid, fish oil ; but all these injure the grain and reduce germination.

### III. OTHER CROPS

If one wishes to improve the potato crop seed tuber disinfection is necessary against such diseases as black leg, rhizoctonia and scab. For this formalin treatment is best.

1. *Formalin method.*—A solution of formalin is prepared of a strength of one pint in 30 gallons of water and the tubers are soaked in this for two hours.

2. *Corrosive Sublimate.*—This is used at a strength of 1 in 1000 but it is a dangerous poison so that it is not in common use by farmers.

Cabbages, etc. suffer from black rot and bacterial wilt, which are seed borne diseases.

Stevens and Hall (Diseases of Economic Plants) recommend soaking the seed in the following solution :—

1 part of corrosive sublimate.
2 parts of hypochloric acid.
1000 parts of water.

On the other hand Duggar recommends a bath of fifteen minutes in a solution of corrosive sublimate 1 in 1000. Howitt finds that the same results are obtained by using formalin 1 in 1000 for fifteen minutes.

Finally Geunaux finds that for the root rot of cabbage copper sulphate (1%) can be used in place of formalin if the injury is serious.

Onion bulbs are disinfected by using commercial formalin 1 in 300(Geunaux).

In order to control onion smut contaminated soil should be disinfected with formalin 1 in 300. This requires 125 to 150 gallons per acre (Howitt, Ont. Bull. 258). Another method consists in sowing the seed and watering with dilute formalin solution before covering the seed.

Beans and peas infested by weevils can be treated with carbon bi-sulphide in a closed vessel. The vapour—dangerous to handle because it is very inflammable—kills the insects in the seeds in 48 hours. It is used in a concentration of three ounces to a barrel.

In certain cases soil treatment replaces seed treatment when the spores live over in the ground and not on the seed.

In order to prevent diseases in the seed bed of tobacco, one sterilizes the soil with formalin 1 in 100 or with steam. The same method is used in avoiding lettuce drop.

In forestry nurseries the soil is disinfected with formalin 1 in 50, or with sulphuretted hydrogen (Truffaut), or with carbon bi-sulphide.

In some districts growers complain of the ravages of rodents which attack and destroy corn when sown. Farmer's Bulletin 932 states that this trouble occurs in certain of the western sections. It is suggested that to control the following method be employed. A soup-spoonful of tar is added to a gallon of boiling water which is then allowed to cool. When cool the grain is poured in and stirred about for some minutes. No injurious effect is noticed in the germination of corn so treated. We have not had occasion to observe the ravages of rodents in Quebec in anything like an epidemic.

# THE DISCOVERY OF THE EUROPEAN CORN BORER IN SOUTHERN ONTARIO

**Leonard S. McLaine, Chief, Division Foreign Pests Suppression, Entomological Branch, Ottawa.**

Ever since the European Corn Borer was realized to be a serious pest, that is in the summer of 1918, the Dominion Department of Agriculture has taken steps to warn the general public of the danger of introducing the pest into the corn growing sections of Canada, as well as to find out if the pest had already been introduced.

It was with this latter object in view that scouting work for the European Corn Borer was carried on in the Maritime provinces in the summer of 1919. In the fall of the same year this insect was found in western New York bordering the shores of Lake Erie. Through the co-operation of the United States officials in charge of the work, two Dominion scouts proceeded to the New York outbreak to receive instruction in scouting for the pest. They later scouted in Welland County, Ontario, but the work was soon discontinued on account of the lateness of the season and the general weather conditions. Plans were formed, however, for extensive scouting to be carried on in southern Ontario during the summer of 1920, special attention being paid to the districts bordering on Lake Erie.

Early in August two scouts equipped with motorcycles, started the scouting work as the corn was coming into tassel. On August tenth Messrs. Keenan and Simpson found some suspicious looking larvae in a field of ensilage corn, near Lorraine Station, Humberstone Township, Welland County. The larvae collected were very small and identification was difficult. These and later collections were forwarded to Dr. J. M. McDunnough, Chief of the Division of Systematic Entomology, for determination and were identified by him as being larvae of the European Corn Borer (*Pyrausta nubilalis* Hubner). Plans were then formulated to determine the area infested by the insect.

On August 22nd a farmer in the vicinity of Aylmer, Ontario, submitted samples of larvae to the Dominion Entomologist and these were also determined by Dr. McDunnough as those of the European Corn Borer. A preliminary examination of the fields in this locality indicated that the intensity of the infestation was much greater than that in Welland County.

The season was advancing rapidly and with apparently two distinct infestations to deal with, it was necessary to take on additional men and furnish better means of transportation. The Ontario Department of Agriculture cooperated in this scouting work through the courtesy of Professor L. Caesar,

by supplying a Ford Car and three or four men. A Ford car and additional men were also engaged on the work by the Entomological Branch. As a result of this increase in staff, better transportation facilities, and exceptionally fine weather conditions, the scouting work proceeded at a rapid rate and the infested area, as far as we are aware, was covered by October 23rd when the work was closed down for the season.

The amount of territory covered by this field scouting includes thirteen counties, of which seven were found to be infested ; in all one hundred and five townships in the above counties were inspected of which thirty-five were found to be infested. The scouting work indicated that there are two distinct and more or less widely separated infestations of the European Corn Borer, known in southern Ontario at the present time. Two separate attempts were made to connect these infestations but without success.

Infestation No 1 centers around Ridgeway and Crystal Beach, it extends along the Lake Erie shore from Fort Erie on the east to Dunnville on the west and Stevensville on the north. It covers approximately three hundred and forty square miles.

Infestation No. 2 centers about St. Thomas in Elgin county, it extends from Bayham township on the east to Harwich township on the west, and to Farquhar, Usborne township on the north. It covers approximately three thousand four hundred and thirty square miles.

The Ridgeway and Crystal Beach infestation is very light in character and, with the exception of one field, the amount of damage done so far is practically negligible. It is confined to a comparatively small area and only a few borers were found in any one single field. As compared with infestation No. 2 it is evidently of recent origin and from evidence gathered from various sources it appears as if the pest was introduced into this district on shipments of sweet corn on the cob, from the infested areas in western New York. Crystal Beach is a summer resort largely used by residents of Buffalo. During the summer months, excursion steamers run at frequent intervals between Buffalo and the resort. As the trip only takes one hour, it is customary for the residents to do much of their shopping in Buffalo. There is also a rapid ferry service between Black Rock, N. Y. and Fort Erie, Ontario, and hundreds of automobiles come across on the ferry on fine summer days.

Judging from observation already made, Infestation No. 2 is apparently of much older origin. The area infested is ten times as large as No. 1 and the degree of infestation in the centre of the area very much greater. The amount of field infestation runs from nothing to 99 per cent. In one field near Union Station, consisting of eight acres of flint corn, a very careful study of conditions was made and it was found that ninety-three per cent of the plants had been or

were infested by the borers. Dent corn does not appear to be as readily attacked as flint, as the highest percentage of infestation found in a field of dent corn was forty-five. Intensive investigations were started soon after the borer was found, to determine the amount of actual damage done by the pest. These are still being carried out by Mr. H. G. Crawford, of the Division of field crop and garden insects, who has immediate charge of the work, and the final results have not yet been compiled.

The United States officials are strongly of the opinion that the European Corn Borer was introduced into the United States on shipments of broom corn imported from 1909-1912. This was substantiated by a shipment of broom corn being received at the port of New York from Italy, during the spring of 1920, heavily infested with borers. Enquiries conducted by the Entomological Branch, have shown that in 1909 the largest corn broom factory in Canada was operating in the St. Thomas district. Between 1909-1911 hundreds of tons of broom corn were imported from central Europe by this firm, on account of the shortage of broom corn in the southern United States. Although this evidence can by no means be regarded as conclusive, nevertheless it is the most important that has been obtained to date.

In order to prevent the spread of the borer by artificial means, an embargo was passed on November 29th, 1920, which prohibits the movement of corn fodder or corn stalks, including broom corn, whether used for packing or other purposes, green sweet corn, roasting ears, corn on the cob or corn cobs from the areas infested by the European corn borer. Five exceptions are made to this Quarantine, the two chief ones being that it shall not apply to clean shelled corn or clean seed of broom corn, and the second permits the forwarding of seed corn on the cob to exhibitions of recognized standing, such exhibits are examined at point of destination by an authorized inspector.

# GERMINATION OF TELIOSPORES OF PUCCINIA ANTIRRHINI

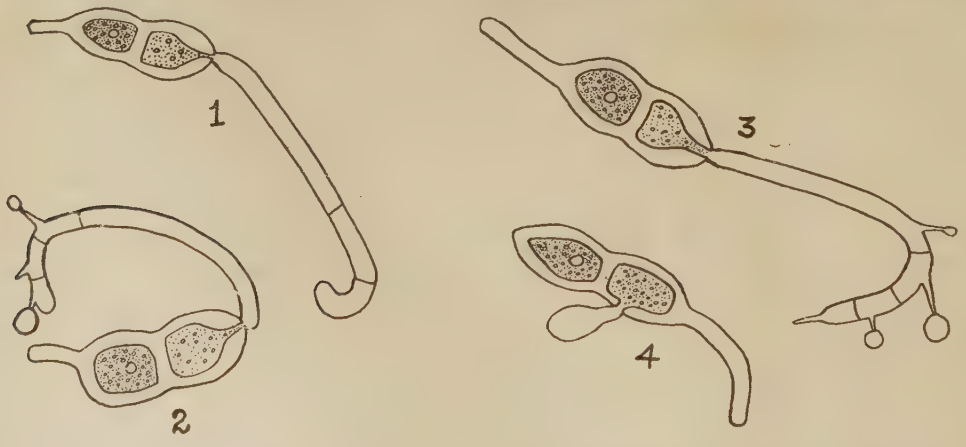
By J. F. Hockey, B.S.A.

At the twelfth Annual Meeting of this Society, Professor B. T. Dickson, Macdonald College, presented a paper—"Some Plant Diseases in the Greenhouse,"—in which he made reference to a rust on snapdragons (*Antirrhinum Majus, L.*) In that paper reference was made to the finding of both uredíniospores and teliospores, the latter being mush less plentiful. The urediniospores, as stated, germinate readily in a few hours, but the writer has been unable to find any record of the germination of teliospores in available literature. It is the purpose of this paper to present the results of experiments, carried on under Professor Dickson, on the germination of the teliospores of *Puccinia Antirrhini.*

## Source and Description of Material

The material for these experiments was obtained from the College greenhouses on January 5th, 1921. A crop of snap-dragons had been growing in one of the beds but, owing to a severe outbreak of rust, the entire crop was pulled up and thrown on the compost heap. Specimens of badly diseased plants were taken from this pile the following day, the plants having been severely frozen.

The rust was determined as *Puccinia Antirrhini*, Diet. and Halw., according to the description by Saccordo (7). The teliospores were found on the branches and stems of the plant in elongate and round sori either mixed with




Germinating teliospores of *P. Antirrhini.* Figs. 1 and 4, after 24 hours in hanging drop culture. Figs. 2 and 3, after 48 hours in culture, showing four-celled promycelia with sterigmata bearing sporidia on their tips.

urediniospores or in separate telia. It cannot be said that the teliospores are produced only in the elongate sori, as many were found in the round sori commonly considered to be uredinia. The teliospores are thick-walled and two-celled with a slight constriction of the spore wall at the septum. They are darker than the uredinio-spores and usually bear persistent pedicels giving them a club-shaped appearance.

## Scope of Experimental Work

Peltier (6, page 538) writes : "All efforts to germinate the teliospores have failed. The spores were subjected by the author to alternate wetting and drying to high and low temperatures and to various outdoor conditions through the winter and summer. The gelatine plate method was also tried under different conditions, but with no success." No details are given concerning the lowest temperatures to which the spores were subjected in the outdoor conditions.

In order to corroborate these results, in part, hanging drop cultures of teliospores which had been frozen for one day were made in distilled water. After one day 5% of the teliospores had germinated from one cell, usually the apical cell. After two days 14% had germinated with the production of four-celled promycelia, some bearing sporidia on short sterigmata. This result led the writer to carry on further tests to determine, if possible, the maximum germination after the spores had been subjected to outdoor conditions for varying periods.

Other experiments to determine whether the rust was autœcious or hetercœcious were also conducted, but the writer was unable to complete them. However, the results obtained to date are given here.

## Experiments in Germination

All hanging drop cultures were made with ring cells and incubated in a moist chamber at room temperature. The most uniform results were obtained by the use of distilled water and tap water. Spore cultures were also made in 1% saccharose and 1% destrose solutions, but only slight germinations were obtained. The results of the experiments may be tabulated as follows :—

| *Period Frozen* | *Date Cultured* | *Media* | *Per cent of Germination* |
|---|---|---|---|
| 1 day | Jan. 10 | Aq. dist. | 14% |
| 7 days | Jan. 11 | " | 16% |
| 7 days | Jan. 11 | Tap Water | 12% |
| 14 days | Jan. 18 | Tap Water | 22% |
| 14 days | Jan. 19 | Aq. dist. | 14% |

The viable spores germinated in two days and only in rare instances did any germinate after two days in the hanging drop.

Spores taken from a plant which had been frozen seven days, kept at room temperature four days, then frozen again for four weeks gave only a slight germination (2%).

The promycelia varied in length from one to four times the length of the spores. The sporidia were hyaline, spherical to obovate, smooth, varying in diameter from 4—9 microns.

A record of the meteorological observations for the month of January was obtained from McGill University in order to have accurate data of the temperature for the period January 4th to 18th inclusive.

| *Days* | *Mean.* | *Max.* | *Min.* | *Range.* |
|---|---|---|---|---|
| January 4 | 32.9 | 36.8 | 29.0 | 7.8 |
| 5 | 29.0 | 32.2 | 23.7 | 8.5 |
| 6 | 17.6 | 23.7 | 11.8 | 11.9 |
| 7 | 14.8 | 23.5 | 6.0 | 17.5 |
| 8 | 24.0 | 27.0 | 21.0 | 6.0 |
| 9 | 22.5 | 28.0 | 19.8 | 8.2 |
| 10 | 25.8 | 32.8 | 19.9 | 12.9 |
| 11 | 25.6 | 31.5 | 21.8 | 9.7 |
| 12 | 13.8 | 18.0 | 6.0 | 12.0 |
| 13 | 3.5 | 10.0 | −4.3 | 14.3 |
| 14 | 17.3 | 27.0 | 6.3 | 20.7 |
| 15 | 28.1 | 31.0 | 20.0 | 11.0 |
| 16 | 8.5 | 19.0 | .5 | 18.5 |
| 17 | 6.7 | 19.4 | −7.5 | 26.9 |
| 18 | −9.8 | −6.8 | −14.2 | 7.4 |

From this record we are able to obtain the lowest and highest temperatures to which the spores were subjected in the different trials. Those that were frozen for one day (January 4-5) were under weather conditions ranging from 36.8 to 23.7, with a mean temperature of 30.6. The spores subjected to outdoor conditions from January 4-11 suffered a range of temperature from 36.8 to 6.0, with a maximum range on January 8th of 17.5. The mean temperature for these seven days was 24.0. The spores that were left outside until January 18th underwent a range in temperature of 51.0 in the two weeks, with the lowest mark—14.2 on the day they were brought indoors. The mean temperature for the two weeks was 18.6. All temperatures are in Fahrenheit Degrees.

### Experiments in Inoculation

Seedling plants of *A. Majus* were inoculated with (a) germinating teliospores bearing sporidia, (b) teliospores from plants which had been frozen two weeks

and (c) viable urediniospores. The plants inoculated with urediniospores were the only ones on which infection was successful. These developed characteristic uredinia in about two weeks. No infection was obtained from the sporidia.

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# METHODS OF PROLONGING THE DURABILITY OF FENCE POSTS

BY J.-A. ROY

It is becoming more and more difficult in Canada to-day to get fence posts of wood that is properly durable. This scarcity is not only tending to enhance the price of the posts, which are so necessary to farmers, but further the products offered are often of secondary quality, or too small in size.

Cedar wood, which resists decay for a long time, even in wet soils, is the kind most in demand for the purpose, but, like others also very suitable, is becoming more and more rare. Such trees as the oak and the chestnut yield wood of great durability, but these are highly valued for other purposes and the idea of using them for fence posts is generally out of the question.

This country possesses many species of forest trees less durable than the cedar, such as poplar, cypress, spruce, fir and willow, and these absorb antiseptic dressings with which they may be treated more easily than hard woods. As the cost of cedar and other durable kinds of wood has increased, the use of inferior varieties has become more common ; if these latter last but a short time, however, it becomes an expensive matter to replace them. In order to practise economy to the best advantage, the cost of any treatment that will prevent, or at least, retard, decay should be considered.

I urge the desirability of practising economy—and very considerable economy—in money outlay, as well as in quantity of timber used.

Let us consider the case of a farmer who possesses an area of land 14,400 feet long by 720 feet broad. As most farmers make their fences with rails, a double quantity of supporting posts will be necessary. Assuming that the stakes are at a mean distance of fifteen feet, one from the other, at least two

thousand of them will be needed in forming the fence all round the area. Purchased stakes cost on the average 20 cents each. This would mean an initial cost of from $350.00 to $450.00.

The second item of cost to consider is that of fixing the posts in position. The farmer will say : "That costs nothing : I do the work myself with the help of my son." But while the farmer and his son are thus occupied, they cannot be doing other work, at which it must be remembered they might be earning $2.50 or $3.00 per day. If the construction of the whole fence occupied the two men for seven days, then we must add to the cost of the material the sum that the two men would have earned had they hired out their labour : from $35.00 to $42.00.

The cost of the posts and their installation will amount to from $400.00 to $500.00, this not including the cross rails. If the fence is to be of wire, the cost of this would be about the same as if rails were used. With a wire fence, posts are used singly. They must be well made in order to serve their purpose well, and be somewhat larger in size than is necessary when rails are used. The price of such posts would be from 25c to 35c each, so that the total cost for all the stakes—not including cost of installation—would be from $250.00 to $350.00

This expenditure for fresh posts will, in general, have to be repeated every eight or ten years, but if the posts have undergone any suitable treatment, especially that with creosote, they will last from twenty to twenty-two years, according to the method employed.

### Economy in Material

I am told that there is not necessarily any waste of material in cutting out posts. The tops of trees are used for this purpose, when trees are cut for firing, or in making a clearing. Every farmer knows how this is done. When a fence needs renewal, he goes over his wood lot and looks out particularly for a suitable cedar tree, and when such a one is found, it is cut down. Sometimes two or three posts are obtained from a single tree ; so that it will be at once realised what a number of trees are required to give two thousand posts. After a few years it will generally be found that the quantity of cedar available is very limited, or that there is none at all. The timber is in such demand that most farmers cut down and sell their cedars.

Under such circumstances the farmer would either content himself with using material less durable than cedar wood, or he might purchase cedar, or other hard wood, from outside.

If the farmer finds himself obliged to use posts of a species less durable than cedar, he will, no doubt, be able to obtain sufficient material from the trees cut down yearly for firewood. Let us consider again the case of the man previously referred to, who, we assumed, is obliged periodically to replace all his fence posts, and who needs at least two thousand stakes for setting up his fence. To get these two thousand stakes it would be necessary for him to cut down such a number of trees, that the refuse left after obtaining the posts would provide all the firewood he needed for a long time. If the material needed is obtained in the ordinary clearing work on the holding, the surplus wood not required at

home could be sold at a profit. Considering these several points, it may be said then that by employing as posts material treated with antiseptic dressings, which make the wood more lasting, the quantity of cedar in the wood lot would be conserved, the area cut periodically for firewood would be lessened, or, on the other hand, would yield a good profit and further, a good sum of money would be saved on the maintenance of the fence.

If the farmer is obliged to purchase the material for his posts, the consideration of the necessity for economical expenditure becomes obvious.

## Kinds of timber that may be used

In districts where post material can be obtained easily and at not too great expense, it matters little what kind of wood is used, but for preference one would select those kinds which last as long as possible. But in parts where timber is not plentiful, one must exercise more care in the choice of the trees that are to be cut down for making into fence posts. Apart from the cost, which is always the most important matter, the following points must be considered :—(1) durability of the wood, (2) symmetry and size, (3) capacity of the wood to hold a nail or staple, and (4), the ease, or otherwise, with which the wood absorbs the antiseptic dressing applied.

(1) *Durability.*—In a soil that is always wet, fence posts last longer than in a site sometimes wet and sometimes dry. Further, posts from trees of slow growth are always more durable than those from quick-growing trees.

(2) *Shape.*—The best fence posts are those from coniferous trees (soft wood) such as the cedar, pine, spruce, etc., and every fence made with stakes of these kinds has a much neater appearance than those having bent or twisted posts.

(3) *Capacity to Hold Staples and Nails.* If it is necessary to use staples and nails, then it is certainly desirable that the posts should be of hard wood.

(4) *Capacity for Absorption of Antiseptic Dressings.*—If posts are employed which have not been submitted to antiseptic treatment, then the time they will last depends to some extent on the amount of heart wood they possess. For this reason posts that have been "squared" last longer. If the posts are to be treated with antiseptic solution, it is better not to remove the sapwood which absorbs the solution better than the heartwood. So far as possible, it is better that the heads of the posts should be cut or shaped to a point, so that rain water shall easily run off. If frost has been found to loosen posts when placed in the ground, they should be sharpened at the lower end before fixing, so that they can be well driven in with the aid of a mallet. In all cases, whether the posts are treated with antiseptic or not, it is a good plan to remove the bark, which offers practically no protection. The bark should certainly be removed thoroughly if the wood is to be treated, for if the inner bark is left on, it has the effect of reducing penetration by the fluid.

Before deciding upon any system of treatment whatever, the net cost should be estimated, as influenced by the following factors : (1) the purchase price of the posts, (2) the cost of removing the bark and seasoning the wood, (3) cost of transport from the place where the trees were cut to where they are to be used, (4) the cost of fixing in position, and finally, the expense entailed by the treatment process.

In order to arrive at a clear idea of the economy, or otherwise, of treatment, the above items of expense will have to be added together, and the total divided by the number of years that a post treated with antiseptic will last, and again by the number of years that an untreated post lasts, and so at last the cost per post per year is known. If ordinary material, needing treatment before using as posts, is employed, the initial expense is less, because time and effort have not been expended in searching for any special kind of wood. The cost of transport should also be small in such a case, i. e., if any ordinary wood,found in abundance on practically every farm, is used. The cost of removing the bark and of seasoning will be higher, for it is necessary that the wood be carefully seasoned and the bark thoroughly removed, before it is used.

The cost of treatment is the most important item, and this will depend on the particular preservative and on the method by which it is applied. If the farmer uses only treated posts, then the annual charge for maintenance will be much less, as the posts last so much longer. A point that must not be forgotten is that the period of treatment for the wood must be quite short.

### Choice of a preservative

Experience has shown that creosote, or anything prepared from oil of tar, is the best preservative for wood that is to be used in wet places, and this for two reasons : (1) Creosote is a chemical poison for the different fungi which bring about the decay of the wood and also for the numerous insects which destroy it ; and (2) Creosote is a heavy oil, insoluble in water. If the wood is thoroughly saturated with creosote, it will take up only very little water. As moisture and air are necessary for the growth of fungi, wood treated in this way will remain sound for an indefinite period.

Other substances can also be employed such as Chloride of Mercury, or of Zinc, or even Sulphate of Copper, or one of many other compounds which are veritable poisons for fungi and insects, but these are all soluble in water and would be dissolved out when the post was established in a damp soil. The wood would then be exposed to attack by agents of destruction.

Creosote is an oily product obtained in the manufacture of coal gas, and is a substance more or less variable in quality. The heavier or more dense the oil that is used, the slower does it penetrate into the wood under treatment ; but such oil does not evaporate readily either during treatment or after. If a lighter liquid is used, penetration takes place readily, but evaporation is also fairly rapid.

Creosote can be obtained in most towns where coal gas is made. In Canada, in 1915, the price varied from ten to twenty-five cents a gallon, and has not advanced much to-day. The rather wide variation in price already mentioned depends on the quality, the specific gravity, the quantity purchased and, finally, the cost of transport.

### Kinds of Wood to Select for Treatment

The selection of kinds of wood that will be suited for our purpose after treatment depends on local conditions. In the Maritime Provinces, the spruce, the fir and the pine offer material that can be economically treated. In Quebec and Ontario, in addition to these three kinds, there are also the cypress and the willow. In British Columbia, the western pine and the poplar are plentiful, and suitable for the purpose. An advantage of this treatment by creosote and other antiseptics, is that it allows the use of a cheap kind of wood, and the variety chosen will depend on the purchase price and the method of treatment adopted.

### Preliminary Preparation of the Wood

When the kind of wood to be used in making the posts has been decided upon, it is prepared in a special manner before treatment with the antiseptic. The trees, or parts of trees, are cut out in the autumn, or early in spring, before the sap has begun to rise in the tree.

The stakes are piled up in tiers, each of 4 or 8 stakes, each set laid crossways on the previous lot, until the pile contains from fifty to sixty posts. These piles are arranged at from twelve to fifteen feet from each other. As the result of this arrangement, the posts will be well seasoned in the summer and will be ready for the creosote treatment in the early autumn. The head of each post should be cut to a point or edge.

### General Object of the Treatment

The aim of the treatment is to secure a penetration by the creosote or other liquid as deeply as possible into the wood, using the smallest possible quantity of liquid and with evaporation reduced to a minimum during treating.

Farmers who have a good deal of fencing to attend to and who use a great number of posts soon become quite capable of carrying out the different methods of treatment described below.

### Setting stones round the Bases of the Posts

Mr. Weiss, in his book entitled "The Preservation of Structural Timber", page 174, suggests that if one can get stones in sufficient quantity it is a good plan, after the post has been placed in the hole dug for it, to fill in with stones, as this would prevent the growth of vegetation, which would otherwise injure the base of the post.

### Carbonisation

Another method of treatment is to first soak the foot of the post in crude tar oil and then slightly carbonise this portion in the fire. Some experiments carried out at the Wyoming Experimental Station, Ohio, on this method, have given satisfactory results.

### Diagonal Perforations

This method consists of boring a number of holes, each about half an inch in diameter and three inches deep, the holes being two or three inches above the soil level and pointing in a slanting direction towards the base of the post. These cavities are filled with some preservative, such as a solution of sulphate of copper or of mercuric chloride, and the mouth of the hole is afterwards closed. When the liquid so enclosed has been absorbed into the wood, the operation is repeated, Mr. Weiss does not recommend this method and gives as his reasons that the boring of the holes weakens the wood, that the liquid enclosed does not reach all parts of the wood, and finally, that the results obtained do not always justify the expense.

### Method of Applying Antiseptic Dressing by a Brush

This is the most economical method of applying the dressing to the posts, and it is from the point of view alone of economical application that it is to be recommended. The method followed is simply to give to the lower part of the post at least three dressings of hot creosote liquid by means of a paint brush, or any other suitable brush. The creosote is warmed, and kept hot throughout the process of treatment. In carrying out this method all cracks and holes in the wood should be filled with the liquid used, and one coating should be allowed to dry thoroughly before the next is laid on. While the dressing is drying, the post is placed with its base upwards so that the liquid has additional opportunity to soak up into the wood. So far as possible this drying should take place while exposed to bright, warm sunshine. If the post is cold, or if the creosote cools too quickly, it tends to solidify on the outside and does not soak into the interior of the wood. If it is desired, a coating of creosote can also be given on the part of the post that will remain above ground. It is customary to treat only the lower part of the post, i. e. the portion that will be in the soil, and also the part up to six inches above ground. This application of creosote by the brush method causes the liquid to penetrate about a quarter of an inch into the wood and this will increase the life of the posts by at least ten years in the case of spruce, pine and poplar material.

### The Dipping Method

This method is advised only in cases where there are but a few posts to be treated. Creosote, or any preparation with creosote as a base, are the best preservatives to employ. The liquid in which the posts are dipped must be warmed to a temperature of at least 150°F. and the time of each dipping should be from 15 to 20 seconds. The lower portions of the stakes must be dipped two or three times, from the base up to a point that will be a foot above the surface of the earth when the post is fixed. Between these several immersions the posts must be allowed to dry thoroughly, or in other words time must be given for the liquid to penetrate the wood.

## The Open Tub Method

This is a simple method of treatment and gives a better return than the preceding one, but the apparatus needed for the carrying it out is more extensive. The posts are heated in a hot bath of creosote which makes the air in the vessels of the wood expand, and converts into vapour the moisture that is in the wood. As a result, part of the contained air and of the moisture is removed. The posts are, after this, placed in a cold tub or copper, or allowed to remain and get cool in the bath, which was previously heated but is now cooled. The contraction of the air and the condensation of water vapour, which take place at the reduced temperature, bring about a partial vacuum, and, as a result, the preservative liquid is forced into the wood by atmospheric pressure. The receptacles used, as well as the details of the method employed, depend on the judgment of the operator and the cost of the material.

An open tub, comparatively inexpensive, which can be employed on all farms consists of a water-tight barrel, three pieces of iron piping and the necessary fittings. One piece of piping passes into the barrel near the bottom, a second higher up, while the third piece connects these two. A number of posts are placed in the barrel, and creosote is poured in to a level above the upper piece of piping. Then a fire is lit beneath the lower pipe, care being exercised that the barrel does not take fire, for creosote is very inflammable and a single spark may be the cause of the destruction of the whole. The heat will circulate slowly and the tar will be raised to boiling point. The heat must be maintained at this temperature, but not allowed to go above 220°F. The loss due to evaporation will be considerable and will vary from 10 to 20 per cent, according to the density of the liquid. When heating is discontinued the stakes are left in this bath so long as any bubbles of air continue to rise to the surface. The time necessary for treatment varies with the nature of the wood, the amount of bark, and the dryness of the material. It may be anything from one to six hours, being a matter for the judgment of the man who is carrying out the work. It is advisable to make a few preliminary trials to ascertain what length of time gives the best results. When it is considered that the heating has proceeded far enough, the fire is extinguished, and the creosote allowed to cool down, but the stakes remain in the liquid for three or four hours longer. This time having elapsed, they are placed in an empty barrel, but they are now upside down, as compared with their position when being boiled in creosote. This is done so that the excess of creosote which has not soaked fully into the wood may have an opportunity of passing down into the portion which was previously uppermost, and therefore not so well penetrated by the creosote.

If it is preferred, however, the posts may be left standing just as they were in the tub in which they were treated, and the surplus creosote collected and used again.

This "open tub" method permits of great variation in the details of treatment and also certain variation in the plant used.

The posts are sometimes lifted out from the tub containing the hot creosote and placed in another receptacle containing cold creosote, where they remain until a sufficient degree of penetration has been reached. If this method is followed, the barrel with the hot liquid can be at once refilled with posts and the operation started again immediately. In this way there will be an economy of time. A wooden vessel sufficiently large to allow the posts to be laid in it on

their side, i. e. completely submerged, is the best to use for the cold liquid. The foot, or lower part of the post, which has been charred or slightly burnt in the fire, will absorb a large quantity of creosote, while the upper part will absorb sufficient to prevent rapid decay. This is a good method of treatment for the more perishable kinds of wood, such as the willow, the poplar and the maple. The same results may be obtained by placing the foot of the post in a tub filled with creosote and, by means of a brush, apply two or three coatings of creosote on the upper part.

The "open tub" method is quite satisfactory when only a small quantity of posts are to be treated, but with a larger quantity it is desirable to have a permanent plant installed. The wooden vessel must be replaced by one made of galvanised iron, in order to avoid the possibility that the former may not always be watertight. The kind of fire described as used with the "open tub" method results in a loss of heat, while, with an iron vessel, the fire can be placed immediately beneath and a chimney of stone or brick constructed. If one prefers to use steam heat, a coiled pipe inside the galvanised iron vessel will prove satisfactory. This prevents all danger of fire and allows the creosote to be kept always at the same temperature with the minimum of evaporation. The piping in the "cold" vessel affords opportunity of again heating the creosote if any risk of solidification exists.

## Cost of Treatment

From the following figures, given by Mr. Weiss, ("The Preservation of Structural Timber," page 178), the cost of treatment by the Brush Method, the Dipping Method and by Impregnation can be calculated :

| | | |
|---|---|---|
| In 1915 the price of | creosote was | 2c per lb. |
| " " | zinc chloride was | 5c " " |
| " " | mercuric chloride was | 70c " " |
| " " | sulphate of copper | 5c " " |

In the case, therefore, of a post seven feet long and six inches thick at the top, the cost by different methods would be :

| | |
|---|---|
| The Brush Treatment | 4c to 6c. |
| The Dipping Method | 5c to 7c. |
| Method of injection with Sulphate of Copper, Zinc Chloride or Mercuric Chloride | 3c to 7c. |
| Injection with Creosote | 12c to 20c. |

If the whole post was "injected," the cost of this method would be doubled.

The following table shows the results of treatment by the different methods in preserving the posts :

| | Length of Life of Posts in Years. | Cost per Post, after Treatment and Placing in Position. |
|---|---|---|
| Non-treated posts | 5 years | 20c. |
| Brush treatment | 9 " | 25c. |
| Dipping method | 11 " | 26c |
| Injection with Chloride of Zinc, or Mercury, or Copper Sulphate | 12 " | 25c. |
| Injection with Creosote | 21 " | 40c. |

Mr. Crumley has given us the following facts in regard to fence posts :—

(1) A large post lasts as long as a small one.

(2) It does not much matter which end of the post is placed in the earth, but preferably it should be the larger end.

(3) In clay soils the upper part of the posts will decay more quickly than the lower, while the opposite effects will be noticed in soils of an open kind, i. e. sandy or gravel.

(4) The posts will last all the longer in a soil that is always moist.

(5) Posts from trees that have grown fast and in the open air are not so durable or lasting as those which have grown in the forest.

(6) It is not a good plan to cut wood for fence posts after the sap has begun to rise.

(7) The heart wood of a tree is not so good as that nearer the exterior.

I give below a table which contains certain information compiled by the Forest Service of Quebec :

| | 1916 | 1917 | 1918 | 1919 |
|---|---|---|---|---|
| Production of Fence Posts in the years | 189,749 | 296,774 | 235,200 | 89,245 |

This gives for the four years a total production of 610,968 posts, of which the cost, when fixed in position, might be estimated at $122,193.00, or about $30,548.00 per year. As I have remarked earlier, if the posts are not treated with creosote, this outlay would have to be repeated yearly. We may now consider the total and the annual expenditure involved in treating the above number of fence posts by the methods mentioned.

| Method of Treatment | Length of Life of the Posts. | Total Cost. | Annual Cost |
|---|---|---|---|
| "Brush" treatment | 9 years | $ 152,742..00 | $ 16,971..33 |
| "Dipping" method | 11 years | 158,851..68 | 14,441..06 |
| Injection with Chloride of Zinc, Chloride of Mercury, or Copper Sulphate | 12 years | 152,742..00 | 12,728..50 |
| Creosote | 21 years | 219,948..48 | 10,473..73 |

If I now make a comparison between the results of the two extreme cases i. e. the posts which get no treatment and those treated with creosote, I find that, proceeding on the first method, at the end of twenty years I should have required 2,443,872 posts, at a cost of $488,774.00, whereas, if treated with creosote, only 610,968 posts would have been needed, of which the cost would be $219,948.48. These figures, you will agree, speak for themselves and express forcibly the economy involved in the creosote method of treatment.

## PLANT DISEASES OF 1920-21

**B. T. Dickson, Professor of Botany, Macdonald College, P. Q.**

In giving this brief account of the commonest diseases of the year, I have thought it best to deal with them on a crop basis where possible.

*Orchard.*—During the season there was little apple scab (*Venturia inaequalis*) but unfortunately an abundance of black rot (*Physalospora cydoniae*). This latter appears to be in sequence with the excessive winter injury arising from the severe winter of 1917-18. These two—winter injury and black rot—constitute one of the important orchard problems in Quebec.

There were sporadic cases of silver leaf (*Stereum purpureum*).

*Field and Garden.*—Pea Beans (*P. vulgaris*) were severely attacked by *Ps. phaseoli* causing blight, and both mosaic and anthracnose were present, the latter only to a slight extent. Broad bean (*Vicia faba*) suffered to the extent of 50% with mosaic.

Sweet peas likewise were affected by mosaic and distinct mottling was observed in the flowers of the red purple varieties.

Clovers generally developed mosaic to a considerable extent.

Red Clover (*T. pratense*) in the experimental plots showed over fifty per cent. In the field yellow sweet clover (*M. officinalis*) and white sweet clover (*M. alba*) were severely affected. Black medick (*M. lupulina*) and Alsike clover (*T. hybridum*) suffered from the same disease, but no percentage counts were taken. Alfalfa (*M. Sativa*) exhibited a speckling similar to that of mosaic, but it cannot yet be stated definitely that alfalfa also has its mosaic.

Experimental work still in progress shows that aphids are albe to inoculate and cross-inoculate *T. pratense, T. hybridum* and *M. lupulina*.. Indications are favourable that the same aphids cause the above mentioned spotting on alfalfa. I have not been able to cross-inoculate from the sweet clovers to other clovers by aphids.

Tomatoes, potatoes and tobacco all developed mosaic. In the tomatoes there was 52% of infected plants and mottling of the fruit was quite common. Streaking of light and dark green was observed in the case of tobacco plants with mosaic.

The potato seed was carefully selected, but in spite of this there was approximately three per cent mosaic, five per cent true leafroll and eight per cent

leafroll caused by *Fusarium sp.* Bacterial stem-rot or black leg (*B. phytophthorus*) was present in one range, but was not serious.

No late blight (*Phytophthora infestans*) appeared until September, when during the last two weeks of the season we had heavy warm rains. As a result of these rains there was a heavy loss of potatoes in storage principally from Fusarium rots—combined with some late blight. This may be explained on the basis that owing to warm rains in the latter part of the season the tubers did not mature sufficiently before harvest and very slight injuries to the skin constitute, under these conditions, a fertile source of trouble in storage.

Raspberries, especially Cuthbert, suffered severely from curl and yellows. At the same time many plants showed typical mosaic symptoms with no signs of curl. There are two possibilities—the curl may be an advanced stage of mosaic, or they may be two different diseases. Symptomatically they are distinct and results of histological studies of the mosaic type agree with those in tobacco, tomato, etc. Further work is in progress on this phase.

Currants again developed the uredinal and telial stages of *Cronartium ribicola*. This has occurred for the last six years without a diseased *Pinus strobus* being found in the vicinity.

*Greenhouse.*—As in the field, tomatoes, especially Livingston Globe and, to a lesser extent, John Baer, suffered from mosaic. *Septoria lycopersici*, causing leaf spot, was present but was not serious.

Seedlings of *Chamaecyparis obtusa* and *Pinus Koraiensis* were damped off by a Fusarium.

Snapdragon rust (*P. antirrhini*) becaume so serious that new seed had to be obtained and all old stock discarded.

*Storage.*—Mention has already been made of potato losses in storage owing to unfavourable weather conditions and infection by *Fusarium spp.*

In apples black rot was fairly common, some excellent mummies with pycnidia being obtained.

Many complaints were made from the Montreal market that apples were packed so that the stalk of one apple pierced the skin of the one above. The injury was followed by infection with *Penicillium glaucum*, which rapidly caused a soft rot.

## SPRAYING VS DUSTING

C. E. Petch, Dominion Entomological Laboratory, Hemmingford, Que.

Spraying and dusting orchards have been carried on generally for several years. In the case of spraying it is about forty years and of dusting about ten years. Therefore, the dusting system is working under the handicap of 30 years investigation and application. If the two systems had developed together, it is impossible to state which would be the more efficient and popular. However, we must judge between the two from the evidence at hand.

In the preparation of this paper the writer was fortunate in having before him an article by G. E. Sanders and A. Kelsall in the January issue of "Scientific Agriculture." These writers covered the subject quite thoroughly and their article will be followed fairly closely, but enlarged or criticised to suit Quebec conditions.

Dusting has many advantages over spraying, and if it were not for the severity of black rot canker in Quebec, spraying might have no advantages over dusting. In this age of high operating expenses speed is one of the main economic points to consider. Dust can certainly be applied much quicker than liquid and the writer's results have shown dusting to be three or more times as fast under similar conditions. This speed allows an application to be made at the proper time, that is during the beginning of a humid spell or at the regular spraying periods mentioned in the spray calendars.

The first year that the writer dusted, the results were excellent for the control of apple scab, in fact, better than with liquids and the applications were made during the heat of the day. However, since then, results have not been so good and it is probably due to dusting in the afternoon instead of in the morning or evening. The results of the first year indicate that dusting could be done any time during the day and good results be obtained. The advantage of the early morning and evening over the intervening period seems to have been well established by other workers. The above observations show dusting to be a time-saving method since dust is best applied during the part of the day unfavorable to most farm work ; spraying on the contrary requires the best of weather and the most important part of the day. The initial expense in purchasing a dusting outfit is about one-half that of a sprayer and the upkeep is considerably less. Sprayer parts soon become corroded and worn out, but the chemicals in a dry state have little effect upon the duster. Therefore, the cost of up keep is much less and the saving in time is also considerable, because, with a sprayer, the broken parts are always discovered when it is in use. The most important and busiest part of the spring is not time for delays and they are not

infrequent where sprayers are used. Furthermore, to replace broken sprayer parts is a difficult and tedious job, owing to the awkward position in which many of the parts are located. With dusters most of the parts are easily accessible. It is also true that the duster ready for action weighs less than a sprayer, but this is not important in the majority of Quebec orchards.

The two outstanding advantages in favor of dusting are : (1) When fungous diseases develop most rapidly the weather is most suitable for dusting but not for spraying ; and, (2) the greater speed, which allows rapid treatment of large areas.

Aside from the above differences, it must be remembered that both systems must primarily be satisfactory for the control of fungous diseases, biting and sucking insects. Of the fungous diseases black rot canker and apple scab are our two most important apple diseases. As to the former, there is no evidence, to the writer's knowledge, to prove that dusting is or is not satisfactory for its control, but for the latter there is plenty of *data* to compare the two systems fairly satisfactorily.

The following figures are taken from Sanders' & Kelsall's article in Scientific Agriculture, Vol. 1, No. 1, pp. 14-18.

| | Years | Unsprayed | Sprayed | Dusted |
|---|---|---|---|---|
| New York | 4 | 43..2 | 11..4 | 12..2 |
| Michigan | 4 | 71..4 | 20..9 | 20..8 |
| Illinois | 4 | 70..4 | 19..1 | 19..9 |
| Nova Scotia | 4 | 51..4 | 12..4 | 12..4 |
| Average of | 16 | 56..5 | 15..6 | 15..6 |

The above table contains the average for four years and includes years of light and heavy scab infestation. However, since heavy infestations are the most valuable tests the following data are quoted :

| Region | Year | Unsprayed | Sprayed | Dusted |
|---|---|---|---|---|
| New York | 1913 | 50..6 | 28..5 | 31..4 |
| " | 1914 | 86..0 | 15..5 | 14..2 |
| Michigan | 1915 | 100..0 | 49..1 | 58..2 |
| " | 1917 | 99..9 | 14..1 | 10..5 |
| " | 1919 | 62..4 | 15..2 | 12..6 |
| Illinois | 1915 | 67..5 | 9..0 | 7..0 |
| " | 1916 | 68..4 | 0..9 | 14..7 |
| " | 1917 | 81..8 | 28..4 | 27..1 |
| " | 1918 | 67..6 | 37..8 | 30..9 |
| Nova Scotia | 1919 | 90..8 | 21..1 | 11..4 |
| " | 1920 | 51..4 | 29..7 | 40..0 |
| Average of 11 years | | 75..1 | 22..7 | 23..5 |

The above tables show neither system to have the advantage when all the years were considered, but when only the heavy infestations are considered there is a slight difference amounting to .8 per cent in favor of spraying. At Hemmingford the following results were obtained in years of heavy infestation :

| Year | Unsprayed | Sprayed | Dusted |
|---|---|---|---|
| 1917 | 80..0 | 1..0 | 3..8 |
| 1918 | 95..0 | ..4 | ..4 |
| 1919 | 93..0 | 20..5 | 62..3 |

The above figures show both systems were satisfactory in 1917 and 1918 but decidedly otherwise for dusting in 1919. There were 3 days separating the 3rd application in 1919. The spraying was done on the 17th and the dusting on the afternoon of the 20th. The weather was as follows :

17th—Misty and warm.
18th—Clear and very warm.
19th—Very warm, rain at night.
20th—Cloudy, warm and muggy.

It is very probable that the scab developed very rapidly during these few days and was largely responsible for the heavy infestation of the dusted apples.

The sprays used were chiefly lime sulphur and arsenate of lead and dusts arsenate of lead and dust sulphur. However, in Nova Scotia, Bordeaux mixture was used sometimes and in Quebec arsenate of lime was used on several occasions both in sprays and dusts.

Another very important thing to consider is the injury to foliage and fruit due to burning. This has appeared more or less severely for the past four years in the sprayed areas but as yet there has been no burning from the application of dusts, which have contained as high as 15 per cent arsenate of lead or 10 per cent arsenate of calcium.

So far as biting insects are concerned all the results the writer has seen show dusted arsenicals as good, and, in most cases, better than sprayed arsenicals. In this connection the following figures on wormy apples are taken from Sanders' & Kelsalls' tables :

| Place | Years | Unsprayed | Sprayed | Dusted |
|---|---|---|---|---|
| New York | 4 | 22..0 | 7..8 | 5..0 |
| Michigan | 2 | 12..0 | 0..4 | 0..07 |
| Illinois | 4 | 44..7 | 8..8 | 8..5 |
| Nova Scotia | 4 | 6..6 | 3..7 | 2..9 |

The above figures are all in favor of dusting. The codling worm upon which apparently the above figures are based is only of minor importance in

Quebec, but the following figures are for insects of great economic importance here :

| Variety | Year | Unsprayed | Sprayed | Dusted |
|---|---|---|---|---|
| Alexander | 1917 | 99..0 | 10..7 | 11..0 |
| Duchess | 1918 | 100..00 | 3..0 | 2..0 |

Further it is very interesting to note that this year (1920) dusting for the control of the apple maggot gave better results than any spraying results ever obtained here. A mixture containing 45 per cent sulphur, 47½ per cent hydrated lime and 7½ per cent calcium arsenate, was applied on July 19th and on August 5th. The dusted trees had less than 1 per cent of the fruit attacked, but the check trees had from 50 per cent to 90 per cent of the fruit injured.

Another very important consideration in comparing these methods is their relative value in controlling sucking insects. In many fruit growing sections this would probably be the most important phase of the subject; but in Quebec it is by far the least important and hardly needs consideration. It is only rarely that aphids are present in sufficient numbers to be of economic importance and the oyster shell bark louse could probably be held in check by dusting.

One of the most difficult comparisons to make is that of cost, because present day dusts are only experimental formulae and as this part of the work is in such a rudimentary condition it is difficult to arrive at conclusions that are satisfactory. However, the following figures are based on experimental work done at Hemmingford :

1917, spraying, $16.09 ; dusting, $30.50.
1918, spraying, $23.70 ; dusting, $40.40.
1919, spraying, $27.58 ; dusting, $27.26.

The above figures for 1917 and 1918 show dusting almost twice as costly as spraying, whereas in 1919 the cost is practically the same. The cause of the great reduction in the cost of dusting was in using a mixture in which the sulphur and poison were greatly reduced and replaced by a cheap filler. If it were not for severe russetting, in some seasons, of our best varieties, Fameuse and McIntosh, Sanders' copper lime arsenic dust would be the cheapest to use, but owing to this defect it is not advisable to use it for the calyx and later applications.

The question of mixtures to suit the numerous conditions existing in various parts of the country is a broad one. So far very little information is at hand, but if the work of the past few years is continued with as much interest for the next ten years, there will probably be dusts equal to liquids for any condition which might arise.

## Conclusions

1. Dusting has developed very rapidly in the past 8 years.

2. The results of experimental work in New York, Michigan, Illinois, Nova Scotia and Quebec show dusting to be as efficient as spraying in the control of apple scab and biting insects.

3. The cost of dusting in the past 2 years has been practically the same as spraying under Quebec conditions.

4. The two most important insecticides, calcium arsenate and lead arsenate may be safely used with either system.

5. Without any reliable data to hand it must be stated that dusting is inferior to spraying for the control of sucking insects. However, there is sufficient evidence at hand to cause us to believe the solution of this problem will be discovered in the next few years.

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# THE IMMUNIZATION OF PLANTS

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The term immunization is used in this paper as meaning the changing of the nature of an individual plant in such a way that it is no longer susceptible to a given pathogene. The application of the principle of immunization probably offers the ideal method of disease control, but, unfortunately, our present knowledge of the best means of bringing about such a desirable condition is as yet rather unsatisfactory. In speaking of immunization in plants it is necessary for us to keep in mind that actual immunity very seldom exists in the plant world. What expresses nearer the truth and is now more commonly used is the term resistance. This latter term is used to express the ability of a plant to develop and function normally under conditions such that other plants of the same species would fail to develop or be destroyed.

The whole problem of the immunization of plants may be considered from two standpoints. First, artificial immunization obtained by introducing into the host certain chemical elements or compounds, and second, natural immunization by the isolation of resistant individuals by straight selection or by hybridization followed by selection.

Research on the first phase of this problem has been considerably stimulated by the success that has followed the use of antitoxins for the prevention of animal diseases. Many attempts to treat plants in a similar manner have been made, usually without due recognition of the totally different structure and mode of life of plants and animals. It is to be expected that due to the crudeness of the methods employed, the majority of attempts to immunize plants by artificial means have failed. The problem, however, offers an interesting and profitable field of investigation.

Efforts to immunize plants by artificial means have been conducted along two definite lines, namely—soil applications and direct injection of serums, toxin and chemicals. The first named line of attack has consisted chiefly in the application to the soil of fertilizing elements or complete commercial fertilizers or the application of copper, iron or manganese sulfates. Laurent (1), in 1899 investigated the rotting of potatoes by bacteria not normally parasitic and found that their attack was either favored or hindered by the application of different fertilizers. Pinchi (2) claimed to have decreased the severity of the attacks of grape mildew by applying copper sulfate to the soil in close proximity to the attacked vines. Marchal (3) reports being able to produce distinct resistance to mildew, in lettuce, by the addition of copper sulfate to the nutrient solution in which the plants were grown. Massee (4) was able to immunize tomatoes against leaf mold, by watering them with a weak copper sulfate solution. Norton, (5) in determining the effect of various chemicals in solution applied to the roots of tomato plants for the control of leaf diseases, obtained on the whole negative results, although a few chemicals seemed to produce added powers of resistance in the plants when inoculated with the disease producing organism.

The method of direct injection of immunizing substances has been revived in late years. Bolley (6) has made use of both nutrients and poisons to control

disease by injections of these substances into trees. Potter (7) used injections of a toxin from soft rot to inhibit the growth of the causal organism of this disease on turnips. Campbell, (8) working in Italy, claims that a wild scion grafted on a cultivated stock renders shoots from peach and apple stocks resistant to peach leaf curl and mildew respectively. Extraradicate introduction of weak solutions of tartaric, citric and malic acids rendered cultivated apples immune to mildew and to certain insects.

These few instances of reported success in artificial immunization are culled from a long list of experiments in which the results were largely negative.

Considerably more progress has been made in securing disease resistance in plants by natural means. This phase of investigation calls for the combined efforts of the plant pathologist and plant breeder. The plant pathologist must search the ranks of our different species for individuals that show more resistance than their fellows to a given pathogene. That plants of a given variety and similar in external appearances differ in their ability to resist the attacks of

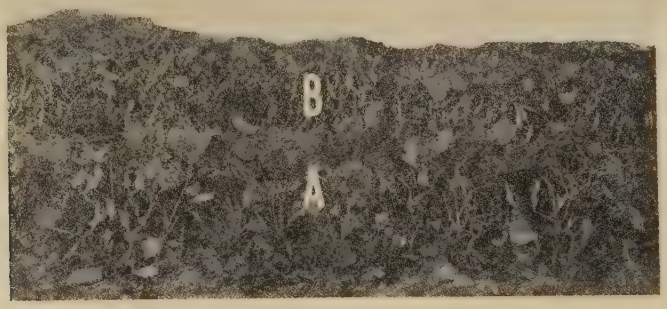


Figure 1.—Two varieties of the white pea bean varying in their resistance to bean mosaic. Row A is badly attacked by mosaic, and in consequence only a very few pods have set. Row B. is resistant to this disease and has an excellent set of pods. Row A. would only yield from two to three bushels per acre, while row B would yield from twenty to twenty-five bushels per acre.

various pathogenes is now common knowledge. Of even more importance from a practical standpoint is the fact that these variations in degree of resistance are, in most cases, definitely inherited. Plants possessing resistance to any particular pathogene can therefore be used as a starting point for the production of resistant strains.

Because of the fact that the isolation of individuals already resistant offers the easiest and least complicated method of obtaining resistant varieties or strains, it is to be expected that the majority of such varieties or strains now in existence should have originated in this manner. This accounts also for the fact that a few of our disease resistant strains have little else to recommend them. If what we desire in this connection already exists, it is obviously unnecessary to seek any farther. However, it often happens that a disease resistant plant may be undesirable in other respects either because of undesirable growth cha-

racteristics or a very limited adaptability. Under such considions, it becomes necessary for the plant breeder to make use of hybridization with other types possessing the desired qualifications, but lacking in their ability to resist the pathogene in question.

The process of producing disease resistant types by hybridization is necessarily slow because of the length of time that is required to isolate and fix the desired type from the miscellaneous population that will appear as the result of crossing. This diversity of the resulting population, while it constitutes a hindrance to rapid progress, is one of the factors in favor of the hybridization method of plant improvement in that the diverse population obtained affords a good opportunity of isolating a plant possessing the maximum of desirable qualities.

A few examples will suffice to illustrate the work that is being done, mainly by our plant pathologists, in the production of resistant strains by the isolation of resistant individuals from commercial varieties. Blinn, (9) by selection within commercial varieties, was able to isolate a cantaloupe resistant to rust. Hansen (10) has secured by selection a type of sand cherry resistant to mildew.

Figure 2.—The condition of the roots of four varieties of beans differing in their resistance to the dry rot organism.

Shamel and Cobey (11) obtained a strain of tobacco resistant to wilt by one year's selection. Bain *et al.* (12) selected a strain of Red Clover apparently resistant to anthracnose. Norton (13) found that the tomato varieties Stone and Stirling Castle possessed considerable resistance to the causal organism of leaf mold. Jones (14) developed a strain of cabbage possessing resistance to yellows. Barrus (15) reports a strain of beans, obtained by a grower from an individual plant selection,which is resistant to both strains of the bean anthracnose fungus.

The possibilities of the slower and more difficult method of securing disease resistant plants by means of hybridization, will be dealt with somewhat more fully. In this connection the work done in securing beans resistant to the causal

organism of bean anthracnose will be used to illustrate both the possibilities and the difficulties of this method of immunization of plants. A few illustrations from work done along this line with other crops will be included for purpose of comparison and of more fully demonstrating the possibilities of this phase of investigation. Biffen (16) and Nilsson-Ehle (17) were each able to secure a number of hybrid wheats resistant to yellow rust from the segregates of crosses between resistant wheats and those susceptible to this disease. Orton (18) obtained the wilt resistant water-melon Conqueror by crossing the citron and watermelon. Tisdale (19) was able to secure a hybrid strain of flax resistant to flax wilt by crosses between resistant and susceptible varieties.

In the case of bean anthracnose two strains of the causal organism have been isolated by Barrus, (20) and the resistance and susceptibility to these

Figure 3.—Four varieties of beans that have been inoculated with strain A. of the bean anthracnose fungus.

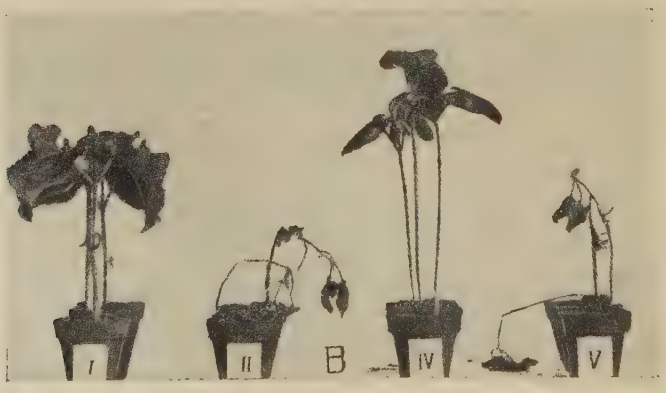


FIGURE 4.—The same four varieties (see Fig. 3) inoculated with strain B. of the bean anthracnose fungus. It is evident that variety No. 1 is resistant to both strains, variety No. 2 resistant to the A. strain but susceptible to the B. strain, variety No. 4 susceptible to the A. strain but resistant to the B. strain, while variety No. 5 is susceptible to both strains of the fungus.

strains of a large number of bean varieties demonstrated. For purposes of discussion the strains will be alluded to as Strain A. and Strain B. Unfortunately very few of our common field or garden varieties of beans are resistant to both of these strains. A considerable number, particularly of our garden beans, are susceptible to both strains of the pathogene. The remaining varieties are either susceptible to Strain A. and resistant to Strain B. or vice versa. This condition of affairs has been both a detriment and an aid in the securing of resistant types. The fact of the existence of two strains of the causal organism has decreased the chances of securing by selection individuals resistant to both of these strains. This same fact was, however, an advantage in that it presented the possibility of hybridizing a desirable variety resistant to Strain A. with a desirable variety resistant to Strain B., and isolating from the offspring strains resistant to both of these strains. This latter possibility was of particular advantage in that the two types of field beans that were resistant to both Strain A. and Strain B. each possessed the disadvantage of being a late maturing variety. One of these varieties also had a colored seed and was in addition very susceptible to bacterial blight.

A type of White Marrow bean resistant to Strain A. was crossed with a white pea bean type resistant to Strain B. The first generation plants of this cross were resistant to both strains of the fungus and the second generation, when inoculated with a mixture of both strains of the fungus, gave resistant and susceptible plants in the proportion of nine resistant to seven susceptible. One ninth of these resistant plants bred true for this character. The remaining eight-ninths when grown to the third generation and re-inoculated gave a proportion of plants that continued to breed true for resistance to both strains in subsequent generations. Of the susceptible class three-sevenths were resistant to Strain A, but susceptible to strain B., three sevenths resistant to Strain B, but susceptible to Strain A and the remaining one-seventh susceptible to both strains of the causal organism. Thus we see that by crossing the two varieties of beans mentioned it was possible to isolate not only strains resistant to, but also strains susceptible to, both strains of the anthracnose fungus, without recource to either a homozygous resistant or a homozygous susceptible variety.

The enormous losses entailed annually from diseases apparently beyond our control by artificial means as well as the labor and expense of our sprayings and seed treatments, point to the necessity of furthering as rapidly as possible natural means of control. Each year we patiently submit to losses from various diseases of our cereal and horticultural crops when such losses could be prevented by intelligent breeding of resistant varieties.

The need of the hour, then, is the closer co-operation between the plant pathologists and the plant breeders of the country, investigators with special training in pathological plant breeding, and finally sufficient moral and financial support to carry this work forward to a successful termination.

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